The AMSAT Journal

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September 1991

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Editorial Staff: Keith Berglund, WB5ZDP, Doug Howard, KG5OA, Ron Long, W8GUS
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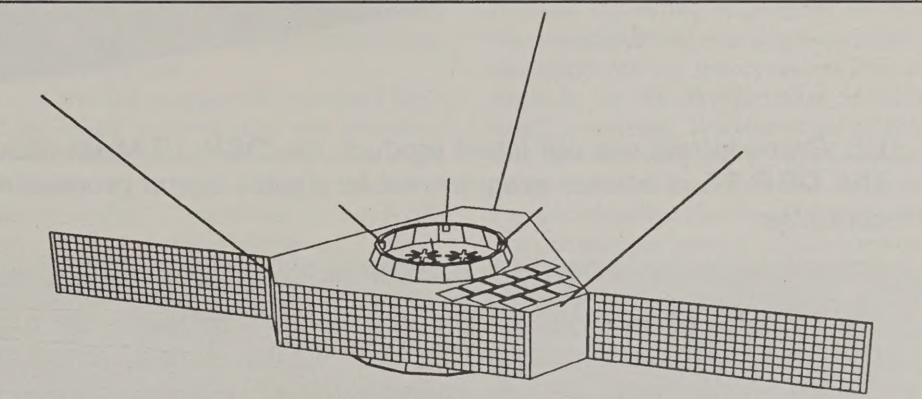

Phase III-D: "The Falcon" spacecraft as drawn by WD4FAB.

Phase III-D has a Go for Launch

By Drew Deskur, KA1M
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It has been worked on for many months. Hundreds of phone calls have been made. Design meetings have been held, involving scores of people from around the world. The Phase III-D juggernaut has built up a considerable head of steam, and finally ESA has allowed us to engage the gears and move forward on our next adventure. On July 15th, ESA, the European Space Administration, announced that AMSAT's Phase III-D spacecraft and mission has been approved for launch aboard the Ariane 502 flight, currently scheduled for October 1995. The Ariane 502 flight will be the second test flight of ESA's Ariane-V launch vehicle, which has been designed to ultimately carry humans into space.

Dubbed "The Falcon" by AMSAT VP of Engineering, Jan King, W3GEY, this will be the most challenging spacecraft design effort AMSAT has ever attempted. The design approved is much like that shown during the design meeting in Marburg in May 1991. It is a seven sided spacecraft bus with a diameter of 3.2m, a height of 650mm and a mass of 500kg. The span of the extended solar panels reaches 6.7m. This spacecraft will have the largest solar panel array surface area of any OSCAR. This translates into a power budget which allows for the most robust transponder arrays ever seen on an OSCAR. Compared to the Microsat design, the projected Phase 3D is not a small spacecraft.

(Continued on page 30)

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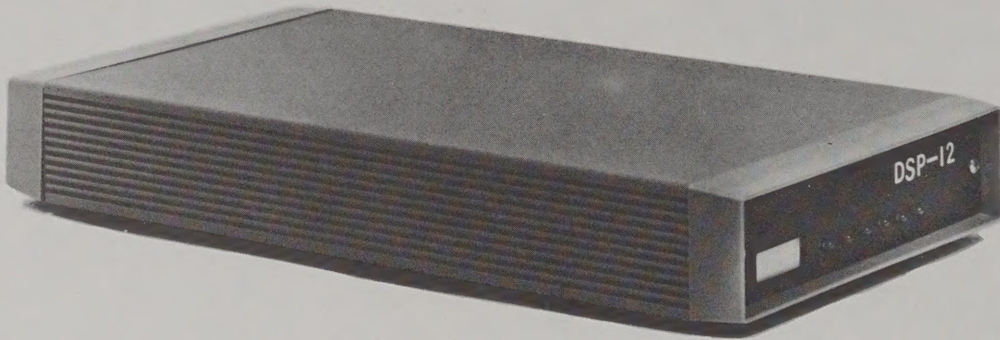

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Sharing the Vision

By Doug Loughmiller, KO5I

The mission of any organization is very important. The vision which the leaders of an organization have for that mission is equally as important. This is certainly true in AMSAT's case.

Over the past several months I have been asked by several of our members about the organization's future. The exact wording of the questions vary from person to person: "Where are we headed?" or, "Why are we working on a given project?" are classic examples. In the final analysis however, the impetus for each such question is the same — What is AMSAT's vision for the future?

It is my belief that the ultimate success of any organization can only be measured comparing the results of its activities against its stated goals and objectives. It only stands to reason that the future planning for an organization must be held to this same set of standards.

It has come to my attention that many members aren't aware of our organizational goals and objectives. These are contained in the organizational by-laws and have been in place since the inception of the organization in 1969. As a means of offering a glimpse into the organization's future, let's review the objectives individually and evaluate how each objective is being currently met.

The first objective: *To provide satellites that can be used for Amateur Radio communication and experimentation by suitably equipped Amateur Radio stations throughout the world on a non-discriminatory basis.*

AMSAT's primary function is spacecraft construction. It goes without saying that there would be no Amateur Satellite Service without Amateur satellites circling the earth. This will continue to be our primary focus. AMSAT has a proud tradition of producing high quality, low cost satellites for use by Amateur Radio operators the globe over. The Amateur Satellite Service currently enjoys a very balanced set of spacecraft available for a wide variety of applications within the Amateur Radio hobby. We will, no doubt, continue this tradition.

Specific programs and projects are however the real issue. Which satellite projects will we select to support? A number of factors enter into the decision making process. User needs and desires are considered when planning for a given mission. Operating frequencies, modulation standards and overall ground station requirements are incorporated into the formula for the development of future satellite systems. It is important to point out, however, that along with providing communications satellites, the above referenced objective clearly states that one of our primary purposes is to provide Amateur satellites for experimental purposes. Again, within the context of a balanced Amateur Satellite Service the importance of these experimental satellites or experimental spacecraft sub-systems on larger satellite buses should not be minimized. Yesterday's "experimental" transponder has today become a mode of operation which now seems commonplace.

It is safe to say that in addition to providing tried and true communications capabilities of various types on the OSCAR satellites there will always be an experimental component to each of the projects we pursue. The legacy of AMSAT and the on-going OSCAR satellite program is one of extraordinary vision and the expansion of the state of the art. The development of experimental spacecrafts and sub-systems have clearly contributed to this legacy. AMSAT's recognition as an international leader in the development of small satellite technology is an enormous source of pride for those who have contributed to the various projects we have brought to fruition. With this in mind the organization will continue to move forward in the development of new technologies and the application of these new technologies to a broad user base.

A prime example of this fact is the Phase IIID spacecraft. As has been well documented in this and previous editions of the *Journal*, AMSAT-NA is committed to supporting this very ambitious project. It goes without saying that this spacecraft plays a prominent place in AMSAT's vision of the future. The goals and objectives for this mission dictate that a balance will exist where the development of experimental systems will work in concert with providing a highly useful operational environment for users the globe over.

Objective number 2: *To encourage the development of skills and the advancement of specialized knowledge in the art and practice of Amateur Radio communications and space science.*

Over the past several years AMSAT volunteers have played an important role in bringing the elements of space science and space communications into the main stream of Amateur Radio. Examples of such activities include: the development of top quality satellite tracking software for use with personal computers, the collection, processing and analysis on spacecraft telemetry as well as the development of ground station hardware for use with the various OSCARs as integral components of an Amateur station. With the development of new satellites and new communication systems AMSAT will continue to play an active role in bringing these activities before the Amateur Radio community.

Objective number 3: *To foster international good will and cooperation through joint experimentation and study, and through the wide participation in these activities on a noncommercial basis by radio amateurs of the world.*

The greatest opportunity for international cooperation within Amateur Radio may very well lie within the construction and operational arenas of the Amateur Satellite program. The tradition of international cooperation is rooted all the way back to the earliest OSCAR satellite construction programs that AMSAT has participated in. The environment in which satellites operate and exist in is truly international. Looking down at earth from the perspective of UoSAT 22 one sees no borders or boundaries and gains a genuine appreciation of just how universal our activities truly are. The international satellite construction community is a very strong one developed from a base of creativity and resourcefulness. AMSAT will continue through its programs and projects to contribute to the enhancement of international goodwill well into the future.

Objective number 4: *To facilitate communications by means of Amateur satellites in times of emergency.*

For a variety of reasons this is a very important objective, vital to the well being of the organization. For those who put so much of themselves into the development of the OSCAR satellites it is very important that the Amateur Satellites be viewed as a powerful resource the potential of which would exceed the boundaries of Amateur Radio itself. It is in the arena of public service where the impact of the OSCARs could potentially have the greatest impact upon society as a whole. This admittedly is an area that we need to make greater strides in. The public service aspects of Amateur Radio can be much better served by the wide variety of OSCAR satellites available today than has been the case in the past. AMSAT is committed to seeing this objective better fulfilled in the future. Is this an area that YOU can offer some expertise, manpower and support to? If so, please let us hear from you.

Objective number 5: *To encourage the more effective and expanded use of the higher frequency Amateur bands.*

The OSCAR satellites represent a unique means of occupying the higher frequency bands for use by a large number of Amateurs over wide geographic areas. In the 70's OSCARs led the charge to the occupying of the 70 cm band, a relatively little used part of the spectrum in that era. Today 70 cm operations are common place. In a similar fashion today bands such as 13 cm see little use. We have began to occupy this spectrum with OSCAR satellites and future payloads will make use of this part of the spectrum as well. Much as was the case with the occupying of the 70 cm band two decades ago AMSAT and the OSCARs are leading the migration to the higher bands, encouraging manufacturers to provide more equipment for use on these frequencies. With the advent of the new "no-code" technician class license even greater pressure will be brought to bear on already crowded VHF and UHF Amateur bands. Communications capabilities particularly wide coverage communications using these bands will undoubtedly be an important and welcomed addition to the already existing resources within Amateur Radio.

One further point is worth mentioning, while this objective encourages the use of the higher frequency bands it does not profess an exclusive use there of. AMSAT is often accused of being a elitist organization who only looks exclusively at moving the operational spacecraft communications systems higher and higher "up the band". This is simply not the case. If one takes a look at all of the Amateur satellites that are available today one sees that the vast number of OSCAR satellites utilize the same frequency combinations today that have been used for the past twenty years. In fact, if one wishes to operate Mode A (two meters up and 10 meters down), the same mode used by OSCARs 6&7, thanks to international coordination between construction groups those modes are still available to operate.

If we can reasonably expect to retain the use of the higher Amateur bands particularly the microwave bands we must occupy and make use of these frequencies. OSCAR satellites are best suited for making the broadest use of these resources and AMSAT will play an important role in seeing that these frequency bands are occupied by Amateur satellites.

Objective number 6: *To disseminate scientific, technical and operational information derived from such communications and experimentation, and to encourage publication of such information in treatises, theses, trade publications, technical journals or other public media.*

As a regular course of affairs AMSAT participates in many professional and academic symposiums and conferences. Every effort is made to make the contributions of the Amateur Satellite Service known to concerns outside of Amateur Radio. Due to these efforts AMSAT has established itself as a leader in the field of small satellite technology. As further advances are made, we will continue to document and report our efforts to the professional and academic world as well as here in the *Journal.*

In addition to the above, I believe that there is yet one more objective which, while not embodied in the by-laws, is considered to be a *de facto* objective. It is:

To promote the use of Amateur satellites and space based Amateur Radio operations as tools in both formal and informal educational settings and to actively work with educators, educators groups and youth organizations in applying the use of said resources for the purpose of exposing young people to the realms of space science, space communications and space travel.

While this has not yet been outlined as a specific organizational goal or objective it is important to point out that it has been observed as an unpublished one to a certain extent. The organization has employed a significant level of manpower and other resources in support of this concept.

I hope from this discussion you have gained a appreciation for the vast potential of the organization and its mission. Further, I hope you have gained an insight into the factors that contribute to the direction our organization is travelling. Exciting activities continue to abound within the world of the Amateur Satellites. New frontiers are being explored on virtually every front the organization participates in. With our proud past of many significant and historical accomplishments as a back drop, AMSAT continues to move Amateur Radio into the future. Many historical milestones are yet to be crossed. With the continued support of membership I am confident that our organization will continue to be a viable and productive entity within Amateur Radio well into the future. ■

Part II

The Second Experimenters' Meeting for Phase-3D

Marburg, Germany May 6-9, 1991

Minutes by Peter Guelzow, DB2OS
AMSAT-DL Journal, Nr.2/18, June/August 1991

Translated by Don Moe, DJØHC/KE6MN

Part I of this article appeared in the July 1991 issue of The AMSAT Journal. *If you don't have a copy of that publication, please contact AMSAT Hq. for a copy (301-589-6062).*

Day 2: Tuesday, May 7, 1991

Karl Meinzer opened the second day's session and quickly reviewed the first day for the newly arrived participants, Andra Gschwindt, HA5WH, and Mr. Callies.

Orbit Design Options

Jan King extensively presented his results for an optimal orbit for the P3D satellite. (Refer to "M/N Resonant Orbits for the Phase-3D Orbit" in the proceedings). Using various graphics and tables he showed the different orbit possibilities, their advantages and disadvantages as well as how good DX possibilities could be achieved for stations in the southern hemisphere. Based on the assumption that P3D performs M orbits in N solar days (24.0000 hours), several different orbits having M/N ratios between 3.0 and 1.4 were investigated. M/N essentially corresponds to the Mean Motion. The perigee was assumed at 4000 km, the inclination at 63.4349° and the argument of perigee at 270°.

An orbit with M/N equal to 3/2 offers several apparent advantages: there are exactly three visible apogee positions directly over the three most populous regions, separated by 120° in longitude (Europe, Asia and North America). Assuming this 3/2 orbit, the visibility of the satellite from the northern and southern hemispheres was considered in relation to the argument of perigee between 270° and 210°. At an argument of perigee of 270° the resulting visibility of P3D is extremely favorable for the northern hemisphere. For a typical location in DL, namely Frankfurt, there are two apogee positions at a maximum elevation of 25°, at 30° and 330° azimuth and the antenna direction varies only slightly during the 12 hour period; thus even fixed antennas could be employed. The third apogee is virtually overhead with nearly 14.5 hours visibility and 12 hours at an elevation greater than 60°, hence ideal for mobile and portable stations with small antennas having a gain of 8.5 to 9.0 dBic.

When the orbital period is considered, there are two ways of adjusting the period of such resonant orbits. If the orbital time is set equal to the number of solar days N (period = 957.2348 minutes), the orbit repeats at the same local time every cycle. However the orbital track, i.e. the longitude of the subsatellite point drifts for an orbit with M/N=3/2 by approximately 2.1° per cycle. On the other hand, if the orbital period is set to N sidereal days (period = 960.0000 minutes), the orbital track repeats every cycle. In this case, the local access time to the satellite will drift by approximately 497 seconds per cycle for the 3/2 orbit.

Stefan Eckart, DL2MDL, presented his orbital analyses in which he compared the 3/2 with the 5/3 orbit scenario, paying particular attention to long-term stability of the orbit. For verification, he compared his computational results with the orbit of AMSAT-OSCAR 13. Furthermore, he performed his stability analysis on the 16-hour orbit for P3D relative to the RAAN. He arrived at the conclusion that all of these orbits are very unstable. At a RAAN of 270° the satellite in the 3/2 orbit would enter the atmosphere after only two years! However, a RAAN between 150° and 180° would be safe for over 10 years. The 5/3 orbit is absolutely safe in this regard.

Karl Meinzer would prefer a sun-synchronous 16-hour orbit coordinated so that the main periods of accessibility fall between 05:00 to 08:00 and 18:00 to 24:00 local time. A 16-hour orbit is also more favorable with regard to the radiation exposure to the satellite.

Karl then went on to describe the necessary procedures to accomplish such orbital maneuvers. The first maneuver would initially ignite the motor at apogee to raise the perigee of the GTO orbit to a safe altitude. The second ignition would occur at perigee in order to raise the apogee height. A third ignition at apogee would then raise the inclination to nearly 64° and optimize the argument of perigee. Karl Meinzer emphasized that reaching this orbit would be no problem with the 400 N motor. Dick Jansson asked whether ESA could be persuaded to launch P3D into our orbit directly (inclination and argument of perigee) if no other passengers were aboard. Karl Meinzer believes that ESA would most likely still launch into the normal GTO orbit in such a case. Should CLUSTER convince ESA to change the orbit, AMSAT would most certainly benefit. The majority of the energy is consumed changing the inclination and CLUSTER would like a high polar orbit.

While discussing the argument of perigee, the fundamental question arose whether the orbit should be optimized for DX or whether special consideration should also be given to mobile communications. For the first year, an argument of perigee between 200° and 225° could be chosen depending on the acceptance by the user community. The motor could later be used to change the orbit. The perigee should be between 2500 and 8000 km, preferably as high as the magnetic position control system allows.

Viktor Kudielka, OE7VKW, was unfortunately unable to attend the meeting personally, but had also prepared a long-term analysis of the orbital options which will be published in the proceedings.

Stefan Eckart and Mr. Callies will investigate the dependency of the RAAN as a function of the launch date, assuming a day launch. The sun would thus be in the direction of the perigee. The launch date is still not known. Mr. Callies will also perform several computations based on the suggested orbital parameters in order to optimize the number of motor burns. For the intended orbit, a further analysis still needs to be performed to assess such items as fuel consumption and long-term stability.

Power Generation

Karl Meinzer explained the relationship between the mission demands and flight orientation of the satellite and the resulting effect on the power generation in the satellite. The key parameters here are the argument of perigee and the RAAN. Using documents appearing in the proceedings, he showed that the power production would never fall below 70%. In the case of a non-rotatable solar generator, approximately 80% of the median power production can be expected, and the surface area could be increased by 20% for a fixed solar generator. He thus concludes that a fixed solar generator should be used. The solar generator should provide nearly 600 W of power.

Jan King reported that the company Solarex is no longer producing space quali-


An Old-World setting for a high-tech meeting. (Photo by Dick Daniels, W4PUJ.)

fied solar cells for satellites, but is concentrating on the terrestrial market. However a new company has been started which might even be able to supply GaAs cells at the same price as the Solarex silicon cells. The price is in the vicinity of $250 (US) per Watt, so that a 600 W generator would cost nearly 300,000 DM.

Following the lunch break, Dick Jansson presented an idea that would permit an extendable solar generator to be attached to the ring structure. Another idea would distribute the fuel tanks in the satellite with regard to the temperature conditions in the satellite.

The battery should be capable of storing more than 400 Watt-hours at a weight of nearly 24 kg, compared to the 100 Watt-hour 6 kg battery aboard AO-13. A larger battery would probably be needed in order to store up to 50% over a period of 1 to 2 hours per orbit and would also be advisable due to the eclipses. The University of Surrey may possibly be willing to supply the batteries. Varta is currently developing a NiH battery which should have the same lifetime as NiCd batteries. Due to the higher currents of the various transponders, the battery voltage would be between 24 and 29 Volts.

IHU and Bus Design

Bob McGwier reported on the status of his work on the IHU for P3D. Five circuit boards with the RCA 1802 and 32K RAM have been built. They correspond to the original design that has been well proven in OSCAR-13. Additionally a serial interface has been added to support a bus system for communications to the various module controllers. The advantage of such a system is the simplification of the cable harness and also an increase in the system flexibility.

There was unfortunately bad news regarding the RTX-2000 processor which has worked quite well in RUDAK-II aboard AO-21. Unfortunately Harris has completely terminated production of this chip. All customer support has been cancelled and Harris is buying back all software tools and even complete development systems at the original price. Since IPS has already been implemented on the RTX-2000 and a large amount of development work has been done, AMSAT-DL will acquire and store several units. The RTX-2000 could be used for RUDAK-III and possibly as backup IHU. There may be a new development for RUDAK-III using a CPU from the 68302 series from Motorola. A 68HC11 could also be used for the various module controllers and there is also a version of the 68HC11 with Forth in ROM.

Gordon Hardman has also been studying the various components and compared the National Semiconductor HPC 16003 with the 80C196. These CPUs have a whole series of interface components integrated in the chip. The component from NSC has already been tested to 25 kRad, which is equivalent to a lifetime of 100 years in a P3D orbit.

Describing the serial bus system, Bob McGwier reported on the good experience during the construction of the Microsats. Each module could be easily tested individually before integrating all subassemblies together in the final stage.

Peter Guelzow, DB2OS, briefly reported on the very reliable ring bus system for the "TheNetNode" packet radio network nodes, that only require a single line in addition to ground in order to interconnect several TNCs. A watchdog timer can bypass or reset a defective unit. Gerhard Metz, DG2CV, recommended additional backup hardware on the ring that does not require a microprocessor. The hardware command decoder for RUDAK-II has been proven and would provide a good starting point.

In the ensuing discussion, no single solution could be found. Karl Meinzer asked all interested groups and individuals to send in appropriate suggestions. A decision about the bus system or a cable harness has to be made as soon as possible! The main points here are:

a) main computer architecture,

b) module controller and

c) bus structure.

A task group consisting of Bob McGwier, Gerhard Metz, Gordon Hardman and Peter Guelzow will investigate the bus and module controller structure.

Attitude Control

The configuration of the magnetic position control system (magnetorquer) can only be determined after ESA has made its decision about the satellite structure. The sensor electronics module (SEU) can likewise only be developed after the sensor requirements have been determined. Probably the previous SEU system will be divided into various submodules.

Power Distribution

Gordon Hardman presented a proposal to perform the voltage regulation by using high efficiency converters in the individual modules. This would allow a higher bus voltage to be used and thus minimize the currents and the resulting voltage drops caused by the high power transponders. A central voltage regulation system as currently implemented in AO-10 and AO-13 would immediately collapse due to the high currents and long cables in the large P3D satellite. The advantage of these local voltage regulators is that they can regulate their loads better and more precisely, and thus are also easier to test. Local regulators have to be carefully developed so that the efficiency does not deteriorate excessively at low load currents. Using a schematic and sample, Gordon showed a regulator for 5 V output at 14 V input at 85% efficiency for currents from 25 mA to 200 mA.

Frequency Management

Freddy de Guchteneire, ON6UG, the general satellite coordinator for all IARU regions, briefly described the internal workings of the IARU and presented an exten-

sive review of the frequency situation, particularly in the satellite segments of the band plans. He is in a position to pass along suggestions and to bring recommendations up for discussion at the IARU, which has a representative from each member country but not from AMSAT.

Starting at the lower frequencies, he reviewed the current frequency situation. He noted that 29 MHz would be ideal for defending the band and is attractive for newcomers. On 145 MHz the situation is more complex. Using a chart he impressively described how the 2 m satellite subband is now heavily occupied by satellites. There is obviously a serious frequency shortage and even over-occupancy in this range. This reinforces the need for eliminating the R8 repeater channel. Freddy recommends that this segment only be used for downlink since the signals from unauthorized FM stations and band intruders have led to very strong interference on the satellite uplink, such as with FUJI-OSCAR 20. Peter Guelzow remarked that even the Mode J uplink to OSCAR-13 is full of FM signals even though only SSB is allowed in this 2m segment according to the band plan.

In the 70 cm band there is still enough space for corresponding uplink and downlink segments, whereby P3D should also use frequencies above 436 MHz. In consideration of the frequency allocations in Italy, only the 435 MHz segment was used for AO-13. In some regions there is additional interference from ATV operation and also from Syledis radar.

For 23 cm (1.2 GHz), a change to the footnote will be sought to permit downlink operation in this frequency range in addition to the current uplink use. For the 13 cm band (2.4 GHz), competition can be expected from terrestrial and satellite based digital audio broadcasting (DAB) as well as mobile satellite uplinks. This frequency band will be under strong commercial pressure at WARC 1992.

The range from 5.6 GHz to 5.8 GHz is not available in all regions. Freddy will check which countries are affected by this, although a downlink would be feasible.

For the 10 GHz high power downlink, the segment from 10.498 GHz to 10.5 GHz was agreed upon since the travelling wave tubes and modifiable satellite receivers can tune to this frequency range.

In conclusion, Freddy asked whether AMSAT should consent to Amateur operation (FM and packet radio) from the space station MIR or the Space Shuttle in the satellite subband. The reaction from the participants was generally negative. [Note: At the annual membership meeting of AMSAT-DL on May 11, the vote was unanimous against such operation because FM stations would cause problems in the already overfilled satellite subband on 2 m.] Freddy made a request of all participants that they write reports and articles about their AMSAT activities, projects, etc, so that these could be published in the *IARU News.*

Jan King considers it important that we notify the appropriate authorities early about the frequency ranges that we intend to occupy. He reported about plans in the USA to use the range 2390 MHz to 2420 MHz for terrestrial and satellite DAB operation. After some discussion, the opinion was that we could definitely not share bands with DAB operations. The "Mobile Satellite Uplink" would be less of a problem on the other hand. AMSAT-NA will submit the appropriate petitions regarding this matter to the FCC in the USA.

Day 3: Wednesday, May 8, 1991

Since several participants regrettably


Bob McGwier, N4HY, seems to be completely focused on something as Doug, Jan, Hennie and Gordon look on. (Photo by Dick Daniels, W4PUJ.)

needed to depart early, the subject of non-transponder payloads was taken up earlier than previously scheduled.

Non-Transponder Payloads

Mikiyasu Nakayama presented the SCOPE (Spacecraft Camera experiment for Observation of Planets and the Earth) project of JAMSAT and showed impressive film material in order to demonstrate various data reduction techniques and the resulting pictures. SCOPE is intended to primarily provide color images of the Earth's surface but can also image the cosmos and the planets. The data transmission format should remain simple for the user and standard formats such as GIF should be used. Additionally, acting as earth, sun and star sensors, the pictures could support the flight navigation system.

Ideally the configuration would consist of three photographic units. Camera A would have a lens with a field of view of 24°. Since the Earth viewed from apogee only has a diameter of 16°, it would only occupy approximately 2/3 of the total picture. The resolution is 756(h) x 581(v) pixels. Activation times of 30 to 60 minutes at apogee would suffice. Camera B would have a field of view of 90° so that the Earth occupies only 1/6 of the image, with the star background comprising the rest. Camera C would have a telescopic lens to scan the entire sky and should be able to provide superior photos of the planets such as Saturn or Jupiter.

Since Jupiter has an apparent diameter of only 30 arc seconds, a lens with a focal length of 3000 mm and 20 cm diameter would be required for pictures of that planet. The CCD sensor has to be cooled to between -20 °C and -30 °C. The orientation of the satellite would have to be maintained to within 3 arc-minutes.

Showing additional photos, Mikiyasu demonstrated how extensively the pictures can be compressed by the JPEG algorithm so that a picture of 900 kBytes reduces to only 9 kBytes. The transmission of the picture data could be performed by the RUDAK-III system. P3D would be the first satellite to provide true color pictures from the green/blue spectrum and even pictures of the launch separation would be feasible. Mikiyasu reported further that the project is under way and that the first test models already exist.

Graham Ratcliff reported about a project by AMSAT-VK in cooperation with various universities to build an infrared camera which could fly with P3D as well as with VK-SAT. The camera does not require extra cooling, needs only 5 W of power and has a volume of approximately 1 liter. A 1 mb picture memory would store four compressed images. A prototype should be ready in 3 to 4 months time.

Matjaz Vidmar has been intensively involved with various digital and analog techniques for picture transmission. Using a home-built station, he has received the high-speed digital images from the NOAA satellites. He critically reviewed the images from all satellites-to-date having CCD cameras. There has been only a single half-way usable image from the two UoSAT's. The images from WEBERSAT have been somewhat better but still leave a lot to be desired. After considering the orbit and link data of NOAA and WEBERSAT, he comes to the conclusion that we could supply pictures equal in quality to those from NOAA. A requirement is that the resolution must be at least 12 bits per pixel in order to allow for poor contrast.

A linear data compression algorithm should be used that does not destroy the original picture. After being processed by the JPEG algorithm, a picture cannot be restored to its original resolution. A linear algorithm could achieve compression factors from 1:2 to 1:4, depending on the contents, such as clouds, mountains, water, etc., and resolution of the picture. In this case however, the data must be transmitted 100% error-free. The loss of a single data packet would prevent restoration of the picture. The problem could be split into two fundamental aspects:

a) how can we build a camera with the highest bits/pixel resolution and

b) how do we transmit the picture information.

Matjaz suggested a separate transmitter with 3 W of output power. The frequency is irrelevant since any additional path loss can be overcome by an appropriate antenna. A frequency around 2.4 GHz might be a good choice. With an antenna gain greater than 15 dBi at the satellite, the radiated power would be more than 20 dBW EIRP. Using a 1 m parabolic antenna on the ground, a data rate of around 200 kBits/sec would be feasible. Matjaz has proven this technique based on reception of the digital NOAA photos. For P3D a PSK modulation at 100 kBits/sec could be used to transmit 10,000 pixels per second. A picture containing 1000 x 1000 pixels would thus require 100 seconds for transmission and data compression could reduce this time to between 25 and 50 seconds.

The data format should be based on frames. Matjaz is absolutely against any kind of HDLC format. Such a frame would consist of a P/N synchronization stream of 1000 bits. The P/N generator/detector is quite simple and is made from a 10 bit shift register where only the "0" data are counted. A header containing the line number and other information follows and would also be used to recognize the polarity of the PSK data since differential encoding is not used. A scan line follows consisting of 10,000 bits (1000 words * 10 bits/word). The complete decoder for the receiving station could be built on a single Euro-Card (160x100 mm). A future study group should devise a suitable transmission standard for the CCD camera experiments.

Andra Gschwindt, HA5WH, reported on the project "RF Ambient Monitor" to measure the interference and noise levels in

the HF range (DC to 30 MHz) to investigate propagation conditions. The ionosphere is being overheated by commercial and industrial high power transmitters. Stations heard beyond the ionosphere are using excessive transmitter power. This facility could serve as a monitor so that such stations would reduce their power. A laboratory version is already in the test phase. Karl Meinzer remarked that due to various legal restrictions perhaps only a statistical catalogue might be permissible. The 10 m antenna or another short active antenna could be used for reception. Karl requested a written proposal so that the idea could be discussed in the other groups. He also requested that link and antenna calculations relative to the galactic noise be performed.

Jay Smith, WA7HBQ, from the Weber State University proposed a stack design as the platform for the individual experiment modules. The various experiments could communicate internally via a separate bus system and be connected to the satellite via a single defined interface. This system could thus be built and tested independently of the satellite and installed during the final integration phase. These modules could be used at universities for educational purposes, which in his opinion would provide more international publicity and may contribute to financing of future projects.

Transponders

Before the individual transponder proposals were discussed, Karl Meinzer described how a rectangular antenna radiation pattern could be achieved. This requires a parabolic reflector, two to three times larger than normal, and illuminated in two planes by a Sin(x)/x function. The design of such a radiator is naturally the main difficulty.

No final decision about the various transponder modes was made at this meeting, rather the goal will be to install as many suitable receivers and transmitters in the satellite as possible. The decision about the operating modes will only be made much later, probably after the launch of P3D, since it is currently not certain which transponder modes will still be possible or desirable in 5 to 10 years time. Several tests of all transponder combinations will certainly precede any decisions.

Knut Brenndorfer, DF8CA, then presented a report from the microwave meeting in Munich where the P3D transponder payload configuration was discussed. The main emphasis centered around the possible transmitters and receivers for the transponders, including 2 m and 70 cm. A common intermediate frequency of 70 MHz and a switching matrix were recommended, as Werner Haas, DJ5KQ, suggested in a recent issue of the *AMSAT-DL Journal*. This switching matrix would permit virtually any combination of receivers and transmitters. Components for the 70 MHz IF are readily available. A second harmonic in the 2 m band is a potential problem, which may require multiple conversion.

Knut also reported on the possibility of implementing a 22.2 GHz water vapor radiometer as suggested by several Radio Amateurs who are active in this frequency range. Furthermore, Knut proposed a 10 meter uplink to provide newcomers a simple entry into satellite communications. According to Karl Meinzer only a 50 cm active antenna would be needed for reception.

Prior to the lunch break, Graham Ratcliff and James Miller, G3RUH, bid farewell. Graham will look into the VK Mode B transponder and the IR camera. James will take on navigation and the sensors.

In light of recent events, the next theme revolved around non-Amateur Radio satellites in the Amateur Radio bands. Indications are that an increasing number of semi-commercial satellites might be operated in the Amateur Radio bands. The IARU has clear directives in this area and will strongly enforce them if necessary by having the national organizations protest to their telecommunications authorities. An example is the French satellite SARA (Satellite for Amateur Radio-Astronomy). The sponsoring group initially requested a frequency in the range reserved for such purposes. The French telecommunications authority rejected this and assigned a frequency in the 2 m satellite subband.

Norbert Notthoff inquired of those present whether anyone knows the downlink frequency of TUBSAT (Technical University of Berlin), since it is reportedly in the region between 147 and 148 MHz, which is allocated in the USA as an Amateur Radio band and could cause problems there. All groups were asked to report similar incidences to their national organizations or the IARU.

Don Moe, DJØHC, mentioned a potential problem with a 10 m uplink where other than Radio Amateurs (e.g. CB operators) could use the satellite. Peter Guelzow reported on the strong interference and noise, etc. on the Mode KT 15 m/2 m transponder on RS-12/13. Often very loud stations can be heard that are not even operating via the satellite. Additionally, class C licensees (no code license) in DL and many other countries are not allowed to operate transmitters on 10 m.

Dick Jansson reported on a design study by AMSAT-NA in which the rotary antenna was investigated more closely. A gain of up to 13.5 dBic can be achieved with a single antenna even though it only has a flat shape. The antenna is circularly polarized. On 10 GHz a gain of 9 dBic would be possible, on 23 cm with several antennas even up to 10 dBic. However the internal losses are quite high at 10%.

Hennie Rheeder, ZS6ALN, then presented AMSAT-SA's 29 MHz experiment with a high power transmitter. The additional ionospheric experiment originally planned had to be deferred due to lack of manpower. He asserted that the sun-synchronous 16 hour orbit of P3D and the regular operating times would be ideal since the experiment would be switched on for only 15 minutes at the top of the hour during perigee. The broadcast transmissions would use AM compatible SSB modulation (CAM) with 100 to 200 W and would thus be easily received with simple ground stations. Currently test transmissions are undertaken each Sunday by AMSAT-SA on 29.4 MHz. The bulletins are transmitted from Johannesburg with nearly 50 W and have raised considerable interest due to the very good audio quality.

Hennie went on to describe the individual aspects of the circuit which consists of a digital section with A/D and D/A converters, a microprocessor and memory for storage of the bulletins, as well as a transmitter section. The high power transmitter has an efficiency of nearly 70% and the bandwidth is at most 50 kHz. A bus voltage of 28V would be ideal for the final stage, but ±14V are also required. Digital as well as analog signals are to be transmitted. The uplink should be in the 70 cm band, however only the command stations should send speech and telecommand data to the experiment. The final downlink frequencies in the vicinity of 29.4 MHz still have to be coordinated with ON6UG and the IARU in order to minimize interference with the RS satellites. In conclusion, Hennie displayed a functional prototype of the 29 MHz high power transmitter.

The broadcast transmissions cannot contain any advertising for the sponsors, especially via the satellite since this would violate current regulations. Mentioning the names of the sponsors in publications however would not be a problem.

Mode B Transponder

AMSAT-Australia (VK5AGR) will build a duplicate of the Mode B transponder from OSCAR-13. However, it does not fit in to the 70 MHz IF matrix concept because it has not yet been modified for LEILA. On behalf of AMSAT-DL, Konrad Hupfer, DJ1EE, expressed his readiness to build a high power transmitter for 2 m and 70 cm with 200 and 300 W of output power. The bandwidth should be more than 100 kHz. All HELAPS modulators will be built at

AMSAT-DL by Werner Haas and Karl Meinzer.

Transponder Matrix

Gordon Hardman has also considered a common IF for the various receivers and recommended 45 MHz. Using block diagrams he explained the interconnection of the various stages. Karl Meinzer asserted that the selection of an IF at 45 or 70 MHz can only be made after the transponder matrix has been determined. None of the uplink ranges should overlap.

Mode L/S Transponder Study

Gordon Hardman has also studied the design of high power transmitters using the HELAPS-C technique for a Mode L 23cm downlink and a Mode S 13 cm downlink, with particular attention paid to selecting the necessary power transistors. Based on the desired link improvements, the output power levels and bandwidths of the transponders are summarized as shown in the chart below.

Karl Meinzer will assist Gordon in obtaining the necessary Valvo PZ2024B24U transistors through AMSAT-DL's good connections. Gordon Hardman was asked to continue his analysis of the L/S band downlinks with more than 200 W.

10 m Uplink

Matjaz Vidmar will build the receiver for the 10m uplink.

X-Band Downlink

Jyri Putkonen, OH7JP, Jukka Sirvio, OH6DD, Esa Haakana, OH3NOD, and Michael Fletcher, OH2AUE, presented their proposal to build a 10 GHz downlink. AMSAT-OH was founded only recently and currently has 20 members; eight are quite active and four attended this P3D meeting. They have microwave experience and have access to suitable measuring equipment in university laboratories. AMSAT-OH expects to finance the manufacturing and component expenses for the X-band transponder through contributions from industry.

Their design includes a 10 GHz transmitter with an IF of 70 MHz and a bandwidth of 40 to 100 kHz. Four transistors will provide an output power of 40 W on 10 GHz. Additionally, a 5.6 to 5.8 GHz transponder is under study, but since this range is not available in all regions, it will have to wait for further information from the IARU. Based on the Mode X link calculations presented, a parabolic reflector with 60 cm diameter and gain of 33 dBi would suffice for a signal to noise ratio of nearly 23.1 dB (NF=1 dB, 40000 km), which should be adequate for SSB and CW.

Various antenna systems have been investigated, including helix and horn antennas. Use of specially shaped lenses improves the illumination of the horn radiator and thus the antenna pattern. AMSAT-OH was asked to investigate whether and how a Sin(x)/x illumination could be achieved. The phase has to be internally adjustable and circular polarization is required. Matjaz Vidmar regards the gain figures for the antennas in the presentation to be overly optimistic. Circuit details will be presented at the next meeting in 1992. An engineering model should be ready by 1993 and the flight model completed in 1994.

Satellite Converter for 10 GHz

Knut Brenndorfer has analyzed several of the common ASTRA satellite converters in view of their possible use for receiving the X-band transponder in the 10 GHz Amateur Radio band. The narrow filter presents several difficulties. Only the newer inexpensive LNC's have wide filters that extend into the Amateur Radio band. However, the internal amplifiers do not pass frequencies below 700 MHz. Unless the local oscillator can be locked in order to improve the short term stability, these LNC's are not suitable. The necessary modifications to remedy these problems could be quite complicated. Matjaz Vidmar reported that GaAs FET's in ceramic packages are light sensitive and would perhaps allow a frequency lock to be achieved.

RUDAK-III

Hanspeter Kuhlen from the RUDAK group provided a status report on RUDAK-II aboard AO-21. Peter Guelzow reviewed the most recent news and information from AMSAT-U.

Hanspeter then proceeded to describe the RUDAK-III system for P3D. Current planning specifies several uplinks at 1200 b/s PSK, same as FO-20, and at 9600 baud along with the corresponding downlinks to serve individual stations. Additionally, a special high speed module is being considered for selected teleport stations and worldwide automatic store and forward operation. However, since we do not want to compete with the post office, 100 Mb/s is not very likely.

Although it can be difficult to connect several transmitters such as the RUDAK beacon and the transponder downlink to a single antenna, it would be a good idea to build separate transmitters for RUDAK. These would not need HELAPS and could thus operate at a higher efficiency. Matjaz Vidmar mentioned that for a microwave downlink we could just install additional antennas. Along this line, Gerhard Metz suggested X-band spot beams to specific high speed teleports.

The normal high speed data traffic should take place in the L band. Mode B would also be of interest for regular user access. RUDAK-III should also exchange high speed data with the CCD unit and transmit picture data. A standardized data format for the internal data exchange will still need to be determined.

Day 4: Thursday, May 9, 1991

On the final day, the participants again discussed the antenna design. A major problem can arise when combining the output power if one amplifier fails. The resulting impedance mismatch can cause the remaining final stages to fail in a domino manner. Such combiners are also quite elaborate and difficult to test.

Rather than combining the output from the final stages and feeding the entire output power to a single antenna, the idea is to use an array of antennas, each being driven by a separate final amplifier stage. By adjusting the phase of the individual antennas in the phased array, the radiation diagram of the satellite antennas could be controlled and directed optimally at the Earth. Should an antenna amplifier fail, the effect on the antenna diagram would be negligible. Ideally the phase angles could be controlled directly at the final stage by computer so that the radiation diagram could be adjusted appropriately. With such a phased array antenna, 16 transistors could even be used for the S-band downlink, resulting in another 3 dB of power (200 to 400 W). The antenna and final stage design should thus be considered as a unit. A technique to control the phase angle in the PA will need to be devised. Karl Meinzer will study the

Downlink Power: Bandwidth vs. Distance

	L-band 36000kM	L-band 49000 kM	S-band 36000 kM	S-band 49000 kM
100 Watts	731 kHz	395 kHz	167 kHz	90 kHz
200 Watts	1405 kHz	758 kHz	298 kHz	161 kHz

optimal configuration for the antennas as well as how to combine them and to control their phase angles. Phased array antennas cannot be used for reception however .

For the design of the X-band antennas, the electrical properties and requirements must be considered primarily and then the mechanical and thermal design. Under no circumstances can plastic materials be used since their electrical properties change due to the effects of radiation.

Receiver-Transponder Matrix

Werner Haas and Karl Meinzer (AMSAT-DL) will build the transponders for Mode B and Mode L and equip them with the previously described LEILA system. In addition to the 10m receiver, Matjaz Vidmar will also build a 13 cm receiver for S-band.

Transmitter-Transponder Matrix

AMSAT-SA will build the 30 MHz downlink. AMSAT-DL will build the 2 m and 70 cm high power transmitters. AMSAT-VK will build a backup Mode B transponder. AMSAT-NA will build the high power 23 cm and 13 cm downlinks. The X-band downlink will be built by AMSAT-OH. Possibly a group from DL will build a downlink for 24 GHz.

23cm Antennas

Dick Jansson and Karl Meinzer will work on the design of the L-band antennas. Nearly 22 dBic can be achieved with four antennas.

70cm Antennas

Crossed dipoles with the satellite as reflector could again be used as on OSCAR-13. With a ring diameter of 4 to 5 wavelengths, 20 to 22 dB antenna gain could be achieved. The dipoles are mounted at 1 wavelength above the satellite surface. Mechanical considerations will have to wait for the ESA decision about the satellite structure.

2m Antennas

The design of the 2m antennas depends mainly on the satellite structure. A configuration similar to OSCAR-13 would achieve nearly 15 dB gain. Dick Jansson was asked to continue the study of 2 m antennas after ESA's decision is known. Dick emphasized that tests with a 1:1 model should be performed as soon as possible.

10m Antenna

As previously discussed, 10 m signals can be easily received with a 50 cm active antenna. According to Karl Meinzer, a circularly polarized antenna made from metal ribbons 3 m long would be suitable for the 10 m transmitter. This could also be used as a receiving antenna without a relay if decoupling of >20 dB can be achieved with diodes.

Command Receiver

For the command receiver, the primary uplink would be in the 70 cm band and the secondary uplink in the 23 cm band. Matjaz Vidmar recommends avoiding any relays in the receiving branch between the antenna and command receiver. A remaining problem is how to switch between the omnidirectional and high-gain antennas. Werner Haas recommends separate command receivers. After the experience with OSCAR 14 and OSCAR 21, Karl Meinzer agrees with this approach.

The Next Meeting

At the next P3D meeting, the internal bus structure of the satellite should be finalized. Dick Jansson expressed his willingness to organize the next meeting in November, 1991 in Orlando, Florida, where 15 to 20 participants are expected to attend. The major points will be the bus design and the bus interfaces. Of course the ESA decision should have been made by that time. The HF side of the transponder will not be discussed at this meeting.

Mikiyasu Nakayama requested that future meetings not be held from April 4 to 8 or around May 10, since it is quite difficult to obtain economical flights during this time.

Karl Meinzer noted that many of the participants come from Europe, South Africa and increasingly from eastern Europe and that flights from DL to USA are excessively expensive due to various regulations. The favorable discount prices from USA to DL are not available to us and this factor should not be underestimated.

It is important to have a 1:1 model by the next meeting. Since the transportation from USA to DL is very difficult, it would doubtless be advisable to build several demonstration models from wood and cardboard so that each participant would also have a feeling for the mechanical dimensions of the satellite.

The decision was then made to hold the next meeting in November in Orlando to be organized by Dick Jansson and with a limited number of participants. The next large meeting will take place again in late May, 1992 in Marburg.

All participants will receive the meeting proceedings, whereby all supporting documents must reach Karl Meinzer no later than June 10. ■

List of Participants

(May 6-9, 1991)

DB2OS	Peter Gülzow	AMSAT-DL
DB8CO	Karl-Max Wagner	
DF5DP	Norbert Notthoff	DARC
DF8CA	Knut Brenndörfer	AMSAT-DL
DG2CV	Gerhard Metz	AMSAT-DL
DJØHC	Don Moe	AMSAT-DL
DJ4ZC	Karl Meinzer	AMSAT-DL
DJ5KQ	Werner Haas	AMSAT-DL
DK1YQ	Hanspeter Kuhlen	AMSAT-DL
DK8CI	Herman Hagn	AMSAT-DL
DL2MDL	Stefan Eckart	AMSAT-DL
EA1KT	Cris G. Loygorri	AMSAT-Spain
HA5WH	Andra Gschwindt	
G3RUH	James Miller	AMSAT-UK
JR1SWB	Mikiyasu Nakayama	JAMSAT
KO5I	Doug Loughmiller	AMSAT-NA
N4HY	Bob McGwier	AMSAT-NA
OH2AUE	Michael Fletcher	AMSAT-OH
OH3NOD	Esa Haakana	AMSAT-OH
OH6DD	Jukka Sirviö	AMSAT-OH
OH7JP	Jyri Putkonen	AMSAT-OH
ON6UG	Freddy de Guchteneire	IARU
VK5AGR	Graham Ratcliff	AMSAT-VK
VK5ZK	Garry Herden	AMSAT-VK
W3GEY	Jan A. King	AMSAT-NA
W4PUJ	Dick Daniels	AMSAT-NA
WA7HBQ	Jay L. Smith	AMSAT-NA
WD4FAB	Dick Jansson	AMSAT-NA
YT3MV	Matjaz Vidmar	
ZS1FE	Gordon Hardman	AMSAT-NA
ZS6ALN	Hennie Rheeder	SA-AMSAT
	Konrad Müller	AMSAT-DL
	Mr. Callies	

An Educational Broadcast Transponder For Phase 3D

The following is a "re-print" of an article which first appeared in the June 1991 issue of SA AMSAT SATELLITE UPDATE, *the monthly publication of the Southern African AMSAT Association. Enjoy! - KG5OA*

By Hans Van De Groenendaal, ZS6AKV
President, SA AMSAT

Introduction

The SA AMSAT (Southern African Amateur Radio Satellite Association) proposal for a broadcast transponder for the Phase 3D international Amateur Radio Satellite was well received at a recent meeting of Designers held in Germany under the auspices of AMSAT-DL. At the meeting, prototype equipment including a CAM (Compatible AM) transmitter and a high efficiency amplifier were presented. This paper explains the system and reviews the progress made to date.

What Is A Broadcast Transponder?

A broadcast transponder is a system that will store up to 15 minutes of digitized speech uplinked on a special service channel to the satellite. The unit will be capable of converting the digital data into speech and transmit this back to earth using compatible AM (CAM), a modulation system that allows the signals to be received on an ordinary AM receiver or a SSB communications receiver. The downlink, which is planned in the 29 MHz band, will allow simple converters to be used together with an inexpensive, off-the-shelf, medium radio.

The broadcast transponder will be used to transmit Amateur Radio and electronically based educational material for the newcomer to Amateur Radio, Novice Radio Amateurs and for use in satellite based projects for schools and other educational institutions.

Compatible AM

Single-Sideband Full-Carrier telephony is the same as Single-Sideband Suppressed-Carrier AM telephony, except that the carrier is re-introduced. It is also known as Compatible AM (CAM) because it can be received on an ordinary AM receiver with no beat frequency oscillator. CAM has a number of additional advantages:

- Receiver tuning is less critical than SSB-SC.
- Bandwidth is half that of Double-Side band AM.
- It is easy to generate using a SSB-SC transmitter by simple insertion of the carrier.

There are also some disadvantages:

- Transmission of carrier reduces available power for sideband.
- Carriers produce unnecessary whistles in the phone band.
- Reception on an ordinary AM receiver is a compromise and not as good as on a SSB receiver.

Not withstanding the disadvantages, CAM has been chosen to give easy and (more important) inexpensive access to the signals by larger groups of people. This is particularly important of the IARU's Promotion of Amateur Radio in Developing Countries program.

Figure 1 shows the proposed circuit diagram of the CAM transmitter using the phase shift method of producing the signal. High pass and low pass filters are used to act as a band pass filter at the audio input stage. This is followed by an automatic gain control stage to ensure optimum signal levels at all times.

A 90 degree audio phase shift network is used to feed two balanced mixers. The output from a radio frequency carrier oscillator at half the final wanted frequency is doubled and fed to a 90 degree RF phase shifter. Outputs from the 90 degree RF phase splitter are used to feed the unaddressed input of the balanced mixers. The mixer outputs (a characteristic of a balanced mixer is the suppression of the input carrier frequency) are combined in an RF combiner where one sideband is reinforced and the other canceled. Another RF combiner is used for final carrier insertion to generate a single sideband with carrier.

The system has been extensively tested on 29.4 MHz and proved very successful. Later this year, the CAM transmitter will be used on 7 MHz for experimental transmission of the SA AMSAT bulletins.

Figure 1 - CAM Transmitter

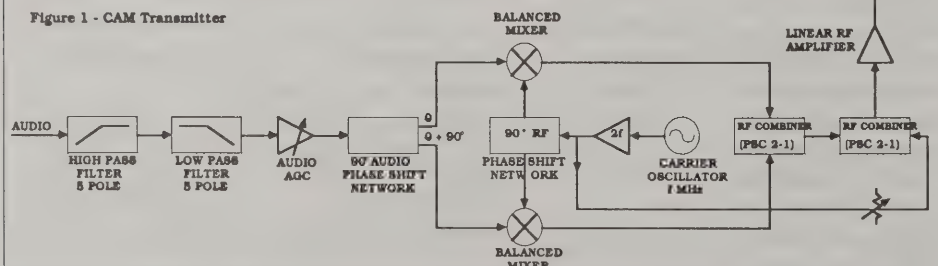
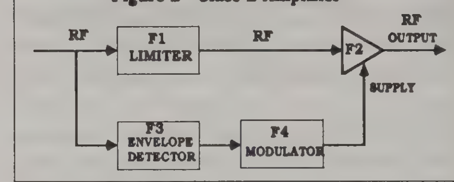


Figure 2 - Class E Amplifier



High Efficiency Amplifier

The success of the broadcast transponder is very much dependent on the signal strength that can be achieved on the ground. A prototype demonstrated in Germany recently was a Class E amplifier which is non-linear, and requires to be fed and modulated by special circuits to affect linear amplification. Figure 2 shows the block diagram of a Class E amplifier.

The modulator circuit requires a Cuk (pronounced chook) topology and is a basic switcher power supply circuit for operation at 300 kHz. A switching frequency of 1 MHz or higher is ideal if suitable ferrite power transformer material is available. The material was not available for the prototype, hence, a bandwidth of only 50 kHz was achieved.

A fairly low power VHF driver transistor (2 watt) was used in the prototype delivering 3.6 watts into a 50 Ohm load. The efficiency of the amplifier is 85%, hence, the ability of the transistor to survive. Only about 0.64 watts is dissipated in the device.

On a class E amplifier, an RF switcher pumps an output tuned circuit in such a way that when the switcher is switched on by the incoming signal, no RF voltage can be present across the transistor due to the phase properties of a special, carefully designed output tuned circuit. Thus, no power can be dissipated in the transistor. In practice, losses are experienced due to slight phase errors depicted by component quality as well as the time taken for the transistor to move out of saturation. Various schemes are currently being looked at to further improve the efficiency to 90% or higher.

A further prototype class E amplifier (with additional circuitry towards achiev-

ing linear amplification) has been designed and constructed with the following performance:

1) 28 MHz - Amateur Radio satellite band capability.
2) 100 W (or +50 dBm) peak RF output for the following peak power levels at each of the following stages:
   * 1 mW (or 0 dBm) at the input to the pre-driver stage;
   * 100 mW (or 20 dBm) at the input to the driver stage;
   * 3.3 W (or 35 dBm) at the input to the output stage.
3) The limiter stage hard limits from -50 dBm.
4) The envelope detector threshold is at 1 mW or 0 dBm.
5) Efficiency (e) = approx. 80%.

The Digital System

A common CMOS 286 type processor is envisaged mainly because it is commonly used in most computers, which simplifies the software development. A very simple digital-to-analog converter will be used on the output stage, implicating that a large amount of memory will be required to store the speech signals. This route will allow almost any signals in the 300 to 3500 Hz range to be transmitted, such as packet signals and various experimental modulation schemes. A low 4-bit D-to-A converter is being looked at which will give approximately 24 dB signal-to-noise ratio.

On the digital input side, it is envisaged to use a simple FAX modem chip. At this stage, a breadboard design is being worked on. It is expected to have a working unit on the air for experimental purposes by the end of this year.

Funding

Funding of the project has, up to now, been done from SA AMSAT funds. However, much more funding will be required. A serious appeal is made to Government Institutions and Industry to assist in this vital project which, once circling the earth in another OSCAR satellite, will do much to activate young people to make a career choice in the Electronics and Communications fields.

Currently, SA AMSAT members have been sponsoring orbits at R100 each. You are invited to do the same. Ultimately, we hope to have between 7,000 and 10,000 orbits sponsored.

For more information about the Orbit sponsorship program, contact SA AMSAT, PO Box 13273, Northmead, 1551, South Africa. Telephone (011) 849-6422 or FAX (011) 849-3488. TeleMail: HANSV. CompuServe: 70262,3652. or InterNet: AMSAT@FRD.AC.ZA. ■

At the Dayton Hamvention . . . Top: A dual-helix array for 1269 MHz awaits testing at the antenna gain measurement competition at the Dayton Hamvention - April 1991. Bottom: AMSAT Regional Coordinator Keith Pugh, W5IU, at the AMSAT booth at the 1991 Hamvention in Dayton. (Both photos by Andy MacAllister, WA5ZIB)

AMSAT Software Spotlight:

ORBITS II and ORBITS III

Satellite Tracking Programs for the IBM-PC

This article marks the first installment of a new column we like to call the AMSAT Software Spotlight. AMSAT-NA offers a great number of software packages for a multitude of purposes. In this ongoing column, we will review the capabilities of the software packages available in order to give the AMSAT membership a better idea of what software is at their disposal. This column is being coordinated through the AMSAT-NA Software Manager, Roy Welch, WØSL. Roy will be happy to assist you in any questions regarding AMSAT software. To inquire, you may write to Roy Welch, WØSL, 908 Dutch Mill Drive, Manchester, MO 63011. All orders of AMSAT-NA software may be directed to AMSAT-NA Headquarters, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703; telephone (301)589-6062 (10 a.m. - 6 p.m. eastern).

By Roy Welch, WØSL
AMSAT-NA Software Manager

ORBITS II and ORBITS III are compiled programs that are identical in functionality except for the graphics display. ORBITS II is for use on an IBM-PC or compatible equipped with the standard Color Graphics Adapter (CGA) and Color Monitor. ORBITS III is for use with EGA and VGA equipped systems. Both ORBITS II and ORBITS III are also available in Math co-processor versions. The co-processor versions will run on a PC which does not have the co-processor installed. The co-processor is emulated by the program software to provide the increased co-processor accuracy. The programs will, however, run more slowly because of this emulation. This is objectionable on a standard IBM-PC running at 4.77 MHz without a co-processor. However, on a PC equipped with a 80286 or 80386 CPU running at 16 MHz or faster, the absence of a co-processor does not cause an objectionable slow down. These PCs will run faster than the standard 8088 based PC equipped with the co-processor. The use of the math co-processor will approximately double the speed of graphics updates on the screen. Additionally, it will slightly increase the precision of the calculations in the program. Since Azimuth and Elevation calculated values are rounded to the nearest single decimal place, there is no increased accuracy in these values over the nonco-processor versions. The real improvement then appears to be in the speed increase which is significant in the BATCH and REALTIME modes discussed below.

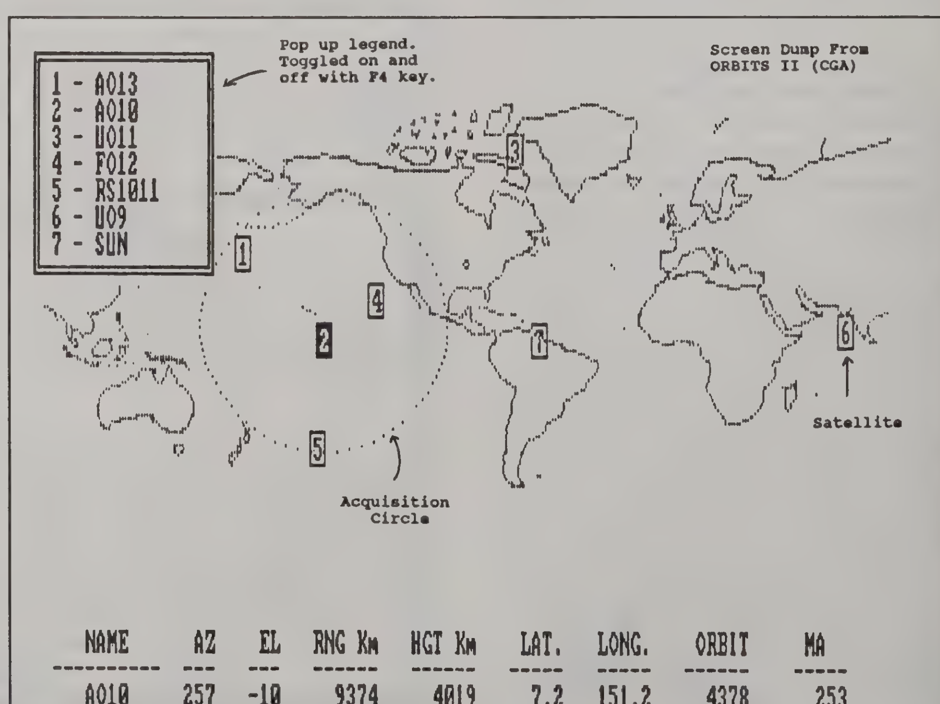
The programs are menu and prompt driven, and provide a BATCH output mode, a REALTIME output mode, a satellite orbital elements update mode, and a ground station and configuration file update mode.

The BATCH mode permits you to select a single satellite and print the tracking "numbers" on the screen, printer or to a disk file. You may specify the date, time and duration of interest. You may also specify the "look interval"; that is, how many minutes you want between "looks."

The REALTIME mode tracks up to nine satellites at a time. The F9 key is used to toggle between a tabulated output and a map graphics output. The F10 key allows you to select a single satellite and see only that satellite's "numbers" at the bottom of the map. In both of these programs, this single satellite select feature also causes a satellite "footprint", or acquisition circle to be drawn around the satellite on the screen. All of the remaining satellites continue to be moved in rapid succession until the selected satellite is updated again and a new footprint is drawn. On a 4.77 MHz system, the nonco-processor versions take about five seconds to move all nine satellites and redraw the footprint. The co-processor versions take approximately half that time. In ORBITS II the selected satellite changes to a reverse video image shape on the screen while in ORBITS III the color of the selected satellite is changed for easy identification. In both programs the satellites are represented by small rectangles on the screen with numbers in them. A pop up legend toggled on and off by the F4 key aids in identification of the satellites by referencing their names to the number in the rectangle.

The programs require you to provide the classical Keplerian orbital elements for each satellite you wish to track. These elements may be entered by selecting an update function from the Main Menu. This function prompts you for the various inputs and stores them in files for use by the tracking program modes. Alternatively, the elements can be updated automatically by inputting a text file with data in either the AMSAT format or the NASA two line format. Both the AMSAT and NASA formats make use of a checksum value to verify the accuracy of the input to the AutoUpdate routines. Keplerian data not passing this test is rejected. Up to seventy-two satellites can be stored, nine in each of eight files.

Both programs have a user selected



PROGRAM FEATURES

FEATURE	ORBITS II	ORBITS III
GENERAL		
*Math Co-processor support	x	x
Julian Day based calculations	x	x
Fully menu driven	x	x
Sidereal Time calculated	x	x
Keplerian element update		
- On Line, manually	x	x
- AutoUpdate (AMSAT or NASA format) with Checksum calculations	x	x
Eight files - 9 satellites each	x	x
Extensive error checking	x	x
OUTPUT		
Azimuth and elevation	x	x
Range and height	x	x
Sub-Satellite point	x	x
Mean Anomaly (Phase) 0 to 256	x	x
Doppler shift (BATCH mode)	x	x
Off Pointing angle (PA)	x	x
REALTIME MODE		
UTC Offset	x	x
Multi-Color graphics		x
Two color graphics (black and ?)	x	
Graphics mode requirements	CGA	EGA or VGA
On line autotracking	x	x
Satellite ID on screen	x	x
Pop-Up legend on screen	x	x
Adjustable Map screen longitude	x	x
Track 9 satellites simultaneously	x	x
BATCH MODE		
Printer output	x	x
Screen output	x	x
Disk file output	x	x
Autotracking in background	x	x
AUTOTRACKING		
Kansas City Tracker Interface	x	x
Command line TSR Vector input	x	x
Enabled from Setup menu	x	x

* Please specify if required.

option to provide an antenna Autotrack capability when the F10 key (selected satellite function) is depressed. You can select a single satellite, have it change to reverse video (ORBITS II) or color (ORBITS III), draw a footprint and steer your antennas in azimuth and elevation, all while still updating the other eight satellites on the screen (maximum of nine). The Autotrack feature is designed to interface with the software device driver standards used by the Kansas City Tracker and will interface with any device driver meeting those standards.

A Ground Station Parameter setup function asks for your latitude, longitude, height above sea level, station identification and on what longitude you want the map centered. The map color in ORBITS II may actually be the default foreground color unless your PC is completely hardware compatible with the IBM-PC. ORBITS III has a more detailed map than ORBITS II and allows you to choose a background color, a satellite color, selected satellite color and footprint color, as well as the color for the text printed at the bottom of the map. Black is only available if you choose it for the background color. The color of the other items can be selected from any of fifteen different colors.

During the parameter setup routine, you are asked whether or not your PC is equipped for Autotrack. If the answer is "NO", then this function is not activated. Later when you want to activate this feature, you can do so.

For those of you who wish to leave your PCs in local time, you can specify a UTC offset value and the programs will set your PC clock to UTC time when the program starts and return it to local time when you exit. Don't forget to do another setup when the time changes to or from daylight savings time.

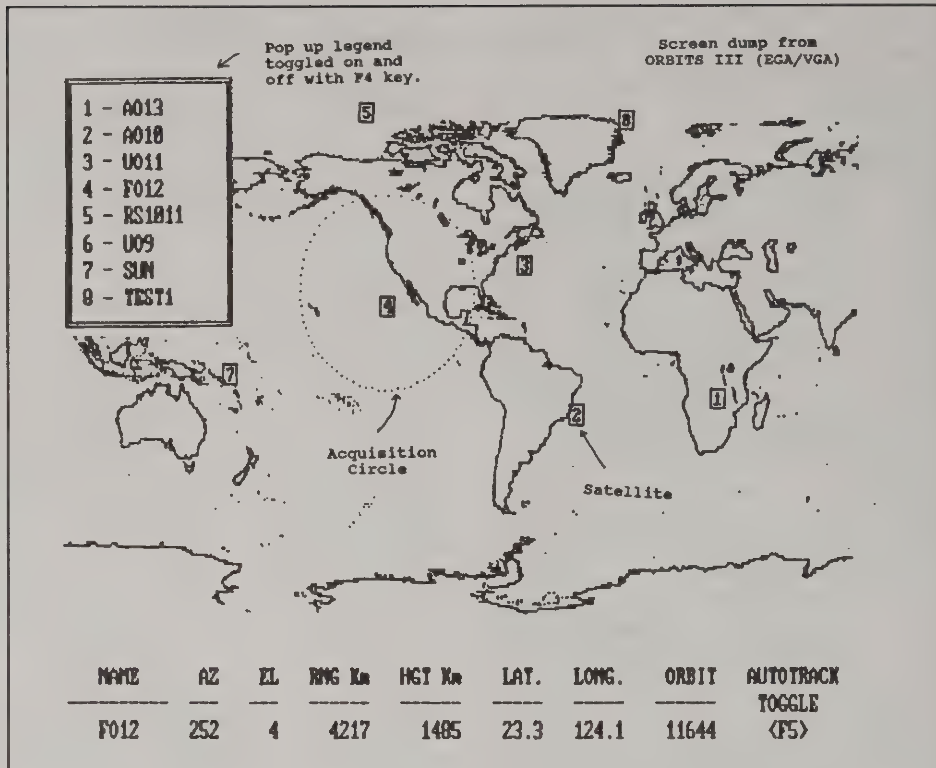
After you have chosen the map colors, etc. you will be asked whether or not you want to redraw the map. The map can be centered on the screen at any longitude, from 0 to 359 degrees west. If you already have the map drawn and centered where you want it, you can answer "NO", and the color changes you selected will be activated without having to redraw the map. A "YES" answer will cause you to be prompted for the centering information input and the map will be redrawn.

An additional feature is the ability to use the F7 key to slow down the rate of satellite updating on the screen. The F8 key can be used to speed it up again. This will help those of you with the new fast PCs where you might want to slow things down a bit. Each toggle will change the update cycle by half a second. There is a limit to two toggles in either direction however, in order to maintain control over the rotor updates while in the Autotrack mode.

If you have the Autotrack capability specified, the BATCH mode will prompt you as to whether or not you want to update a TIME/TARGET table with tracking coordinates for the satellite of interest. If you answer "YES" to this question, the program will pass the tracking coordinates to the Kansas City Tracker (KCT). You may "stack" several passes for different satellites in the table by making several BATCH runs if you wish. Since the REALTIME mode also uses this TSR, the table is cleared upon selecting REALTIME tracking to prevent the table from struggling with the REALTIME routines for control of the rotor system for each time interval you have selected. This will allow you to use your computer for other tasks, such as Packet Radio, etc., while the KCT drives your antennas in the background. This method of "Autotracking" uses only one Terminate and Stay Resident (TSR) program furnished with the KCT. Using only one TSR in the background minimizes the chance of corrupted packets being caused by interrupts while working the Microsat Bulletin Boards in the foreground. If you want to build your own equivalent to the KCT and program

your own Terminate and Stay Resident (TSR) software, you can. The program will interact with your own system if you have adhered to the KCT interface standards. These are covered in detail in the program documentation file included with the program. Information on the Kansas City Tracker can be obtained from the L.L. Grace Co., 41 Acadia Drive, Voorhees, NJ 08043.

The programs will run with DOS 2.0 or later version. The RAM requirements are 512k. The VGA memory requirement for ORBITS III is 512k. While not required, a printer is useful for BATCH run printouts. A single floppy diskette is required since the program and associated files are contained on one diskette. The programs are ready to run as they come on the diskette. They are not packed. The programs will display data for the author's location until the user utilizes the setup option from the main menu to provide his own location coordinates. A documentation file is contained on the program diskette. It is strongly advised that this file be printed and read carefully. It should answer any other questions you might have. ■



The Poor Man's Satellite

By Andy MacAllister, WA5ZIB
14714 Knightsway Drive
Houston, TX 77083

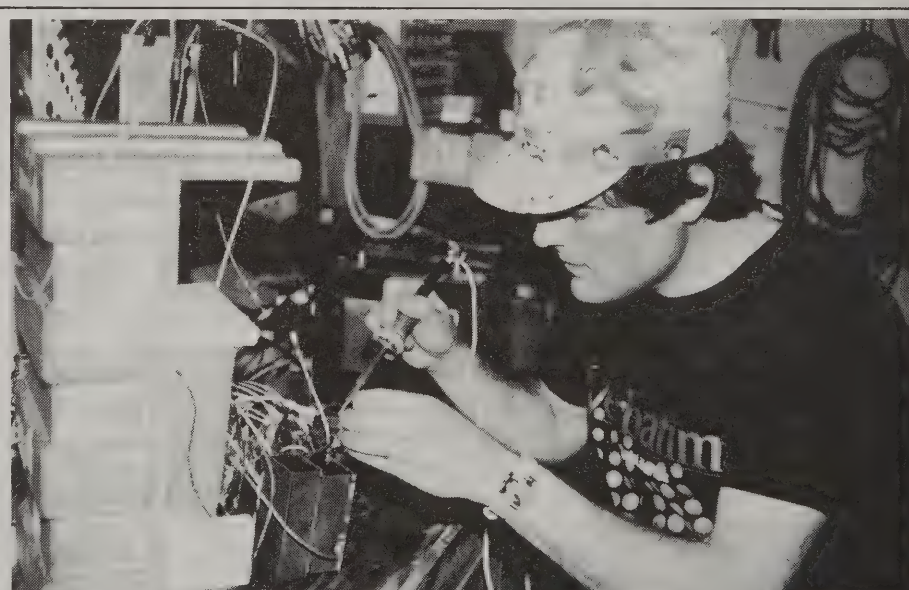
In Martin Davidoff's book *The Satellite Experimenter's Handbook* there is a section entitled, "So You Want to Build a Satellite". Marty briefly describes some of the many concerns facing groups like AMSAT when considering a new Amateur satellite project. It's not easy. From initial project definition to launch, the effort is great and the expense can be prohibitive. But there's an alternative for those interested in satellites who do not have the organization to put a package in orbit; balloons.

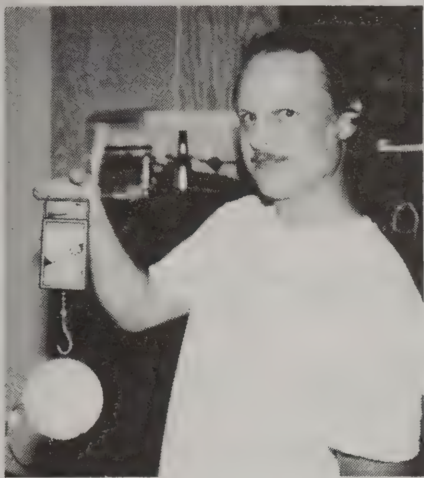
Southern Africa AMSAT (SA AMSAT) has been sending beacons and transponders up for several years. Recovery of their packages after flight has not always been easy, but the opportunity to test electronic designs and work with a team has prepared them for participation in the next international Amateur satellite program.

Balloon experiments here in the U.S. have been numerous. Bill Brown, WB8ELK, has sent several devices to the edge of space using weather balloons. Ranging in complexity from a simple two-meter beacon to Amateur television systems with an on-board camera, his efforts have provided the inspiration to several groups to fly their own.

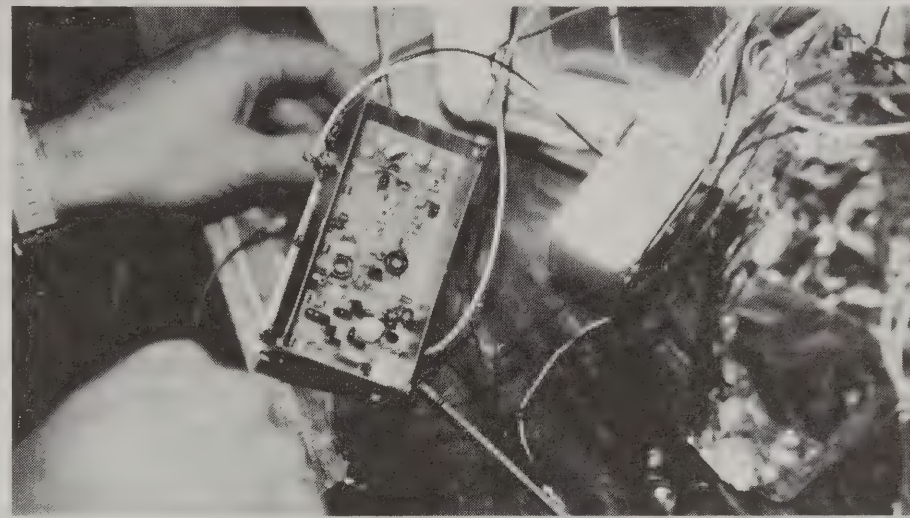
In the summer of 1990 several Houston-area AMSAT members attended Bill Brown's balloon ATV presentation at the Arlington, Texas Hamvention. A week later the Houston group began planning to launch and retrieve a balloon package incorporating 70-cm ATV with digitally recorded audio, packet and MCW on two meters and an HF beacon.

Andy MacAllister, WA5ZIB, was first licensed in 1969 as WN5ZIB. He has a BSEE from the University of Texas at Austin and has an Extra Class License. Andy keeps himself busy by writing the HAMSATS column for *73 Magazine* as well as running the ZRO Memorial Station Performance tests. Andy is presently on the AMSAT Board of Directors and holds the office of VP of User Services.


Andy, WA5ZIB, makes final adjustments to the BLT-2/3 electronics package. (Photo N5LCO)



Mike, WA5TWT, checks the weight of the 10-meter beacon built by Bob, K7IRK. (Photo N5LCO)



Two meter telemetry transmitter for the BLT-1/2/3. (Photo N5LCO)

Why Launch Balloons?

A common question posed by hams is "Why do it"? After some thought, a number of reasons come to mind. Launching a balloon requires group participation in a challenging and fun program. It is a great way to bring a club or group together with a defined goal and an activity everyone can enjoy.

The program must have a leader to handle details like balloon acquisition, helium, scheduling, flight planning and task organization. Another participant should take care of all payload concerns. Together with the efforts of the other team members a system can be built and launched that may be more ambitious than anyone thought possible in the early planning phase of the system design.

Launching a balloon is an opportunity to experiment with telemetry. Whether the data is only simple temperature readings sent via a tone on a transmitter, or a complex collection of values from several sensors, like a satellite, it is satisfying to design, calibrate and launch devices that collect information from a remote system.

AFSK FM packet from a balloon experiment can provide a means for telemetry transmission or it can be used as a digipeater. Other possibilities include an on-board BBS. DOVE-OSCAR 17 is an example of the use of packet for telemetry transmission while the Soviet MIR space station provides BBS activity. With proper safeguards packet can also be used for uplinking commands to payload equipment. Cameras could be rotated, and systems can be turned on or off. The possibilities are many.

Launching a balloon forces the participants to discover meteorology. Knowledge of the upper winds for the launch is imperative otherwise the package may be lost in a swamp, the ocean or a lake. Landing in the middle of a controlled airspace or a major metropolitan area must be avoided.

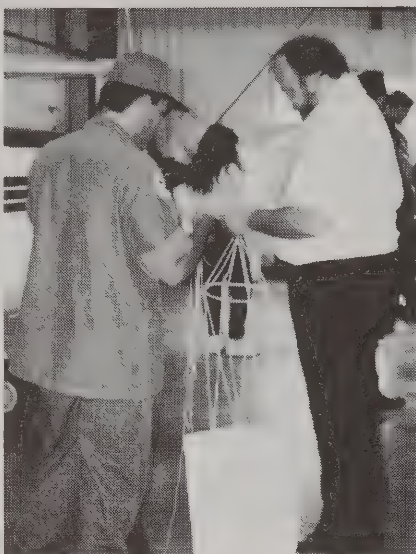
Direction Finding enthusiasts should note that a balloon experiment is the ultimate "fox hunt". No one knows exactly where the package will land and it must be located before the batteries give out. A team of enthusiastic and experienced DF'ers should be on hand, perhaps even with a chase plane.

Designing a system to survive the rigors of low temperatures and near-vacuum conditions is exciting. Cheap components may give out when the outside temperature gets down to minus 60 degrees. Some thermal study of the package is necessary to assure the equipment doesn't freeze or fry. Telemetry devices should be calibrated in environments similar to those expected at altitude.

Making RF-sensitive devices work in close proximity to transmitters is another challenge. The use of shielding materials and ferrite beads on signal and power lines is necessary.

Finally sending it all to the edge of space and watching it work is quite an experience. An ATV transmitter with a camera will see the black of space and the curvature of the earth from 100,000 feet. Pressure readings will show only factions of an inch of Mercury and temperature sensors will detect that point in the sky

Fred, N5JXO, Don, KA3BKU, and Craig, WD5BDX, check weather predictions prior to launch. (Photo N5LCO)



Steve, WB5TTS, gets some help with the parachute lines from the Civil Air Patrol. (Photo N5LCO)

where the readings actually reverse and start warming up again above 60,000 feet.

The South Texas BLT to the Edge of Space

On December 8, 1990, the South Texas Balloon Launch Team successfully sent a two-meter transmitter to the edge of space. Telemetry was relayed to earth for decoding and study by interested hams in Texas, Louisiana, Arkansas and Oklahoma. The package (BLT-1) was later retrieved still transmitting data. It was a simple, inexpensive system. We needed to learn about weather balloons, balloon-flight prediction programs, project coordination and hostile-environment electronics design prior to launching a complex payload.

Styrofoam computer packing material housed the electronics. The transmitter operated on 147.435 MHz and was built from a design in the August 1990 issue of *73 Amateur Radio.* Analog telemetry was generated by a custom system interfaced to temperature sensors inside and outside the package and to the pressure circuitry. The pressure detector came from John Fleischer of the Transolve Corporation. His design was published in the October 1990 issue of *Radio Electronics.* It was originally meant to be used for small rockets flying to 20,000 feet. We used the analog portion of the circuitry and calibrated the unit for a flight to over 100,000 feet. Lithium batteries were incorporated for power, a ground-plane antenna was attached to the top of the package and heat-packs were included to keep the low-power system warm at upper-atmosphere altitudes.

Project coordination was handled by Burns Cleland, WB5HLZ. Hardware and

AMSAT-NA
ANNUAL MEETING AND SPACE SYMPOSIUM AGENDA
November 8-9-10, 1991

(Some times/topics subject to change.)

Friday, November 8 — Los Angeles Airport Holiday Inn
Guest check-in and Participant Registration - All Day

12:00 PM	AMSAT & ARRL Education Workshop	
	Chaired by Rosalie White, WA1STO	Uses of Amateur Radio Satellites in Education. Wide Variety of Topics
3:00 PM	World Space Foundation	Current Projects with AMSAT
3:30 PM	MOVIE - Bill Pasternack, Roy Neal	Amateur Radio in Space
4:15 PM	Joe Kasser, W3/G3ZCZ	Gateways to the 21st Century
4:45 PM	John Fail, KL7GRF	CEØZZZ & XF4L DXpedition Video
5:45 PM	FREE TIME	

Saturday, November 9

8:00 AM	Doug Loughmiller, KO5I	Welcome and Announcements
8:15 AM	Brooks Van Pelt, KB2CST	Developing DSP-12 TNC Applications
8:45 AM	Bob McGwier, N4HY	A Report on DOVE Operations
9:15 AM	Bill Tynan, W3XO	Manned Space, Future Prospects
9:45 AM	BREAK	
10:00 AM	Jan King, W3GEY	The Properties and Stability Characteristics of M/N Resonant Orbits for the Phase 3D Project
10:30 AM	Dick Jansson, WD4FAB	The Shape of Things to Come
11:00 AM	Bob McGwier, N4HY	Phase 3D Project Engineering Report
11:30 AM	Ed Krome, KA9LNV	S-Band Principles and Practices
12:00 AM	LUNCH	
1:00 PM	Open Forum	Members Meet your Board of Directors
1:45 PM	Tom Clark, W3IWI	Chaos, The Eccentricities of Eccentric Orbits
2:15 PM	Harold Price, NK6K Jeff Ward, K8KA	Report on the Viability of Various PACSAT Protocols
2:45 PM	Jeff Wallach, N5ITU	"Image-Enabling" your Satellite Station: A Primer
3:15 PM	Eric Rosenberg, WD3Q	VITA Operations using UoSAT-3
3:45 PM	BREAK	
4:00 PM	Doug Loughmiller, KO5I Keith Pugh, W5IU	Activity with the Soviet Space Exhibit in Fort Worth, Texas
4:30 PM	Jeff Raetzke	What's Happening with WEBERSAT Now
5:00 PM	Joe Kasser, W3/G3ZCZ	Telemetry: Past, Present and Future
5:30 PM	FREE TIME	

Saturday Evening — Los Angeles Airport Holiday Inn

6:30 PM	Attitude Adjustment
7:15 PM	All You Can Eat Gourmet Buffet Dinner
9:00 PM	AMSAT-NA Annual Meeting The President's Report to the Members Current Status of AMSAT-NA Awards Presentations

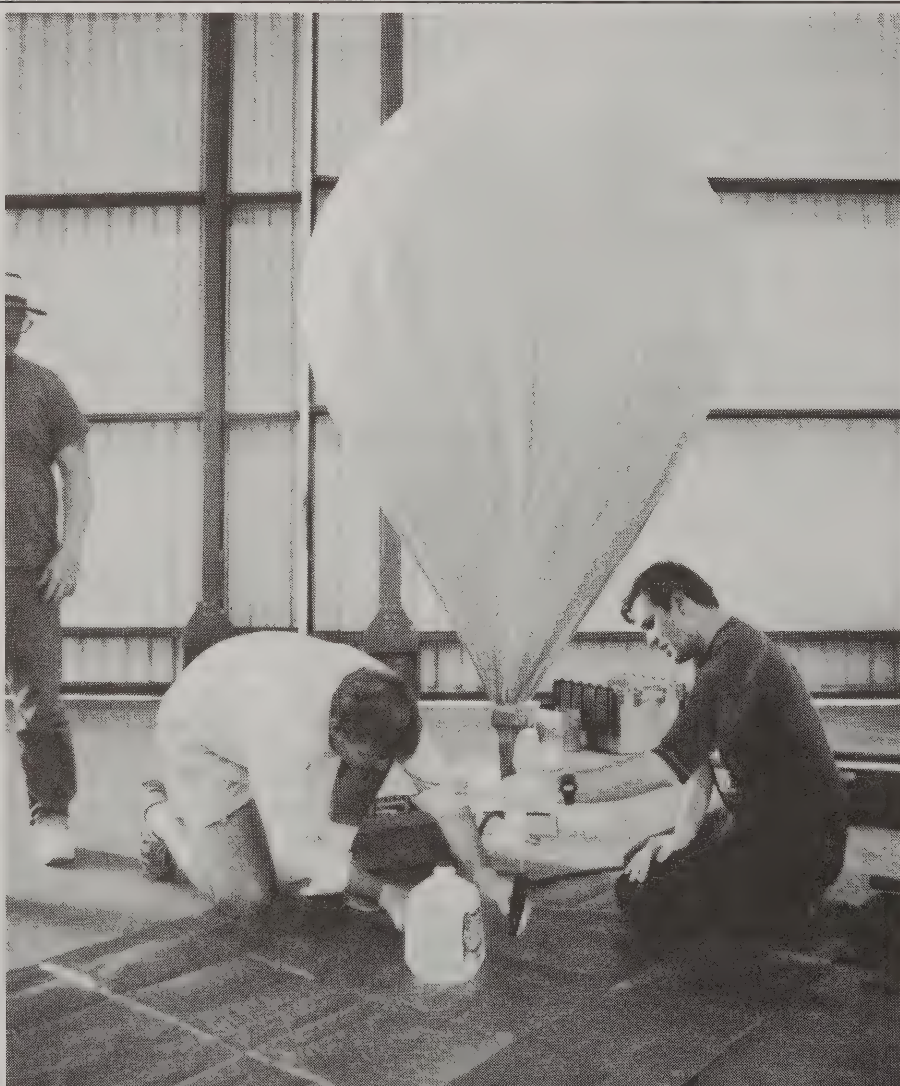
Sunday, November 10

7:15 AM	Field Operations Breakfast	
8:30 AM	Mike Crisler, N4IFD	A Beginner's Satellite Primer and Forum
9:15 AM	JPL Tour	Departure for the Jet Propulsion Laboratory
10:00 AM	JPL Tour	Tour of the Jet Propulsion Laboratory Begins
1:00 PM	JPL Tour	End of the JPL Tour
1:45 PM	JPL Tour	Arrive Back at Hotel

NOTE: Talk-in on Baldwin Hills ARC repeater 146.925 MHz, -600 kHz split, 114.8 Hz PL.

Fred, N5JXO prepares to program the digital voice system for BLT-2/3. (Photo N5LCO)

software came from several hams, all members of the BLT. On the morning of December 8, 1990 we launched from the Huntsville, Texas Municipal Airport just north of Houston. Thirty hours later after a long and difficult chase the package was found hanging at nearly 90 feet from the upper branches of a large pine tree on private land near Magnolia, Texas. Retrieval was Texas style. A local resident shot the line holding the electronics package with a rifle. We won and had learned a lot.



Burns, WB5HLZ, and Fred, N5JXO, begin gassing the balloon for the launch. (Photo N5LCO)

We were now ready for a serious package incorporating ATV, packet telemetry, active mirror control, digital voice and even a HF beacon. Planning began immediately for the May 11, 1991 flight.

With titles like Captain Video, Payload Master and Computer Wizard, the participants whose ranks had grown since the first phase of the program, took on the tasks of a system costing nearly $1000.

Bigger batteries were needed for the complex circuitry. The first package had used sulfur dioxide lithium cells rated for 3 Amp Hours at 12 VDC. The new system utilized similar lithium cells, but at 15 VDC and 7 Amp Hours. A back-up package employing 10 Amp Hour Thionyl Chloride cells was also available. Lithium batteries were chosen due to their power versus weight and size and their ability to work at low temperatures.

A custom on-board computer using the Motorola 6802 microprocessor allowed the analog telemetry to be digested and presented as ASCII text for the packet downlink and MCW output. The computer also watched the pressure changes for increasing values during balloon descent for mirror control. During ascent and shortly after balloon burst the mirror automatically cycled every 50 seconds between horizon views and ground views. After burst the computer would command the mirror to provide only ground views for possible impact determination.

The ATV transmitter on 439.25 MHz by PC Electronics had audio input so a digital-voice storage board was added to send messages on the 4.5 MHz audio subcarrier. Net information and operating frequencies were announced continuously during the flight by the digital-voice system.

A video identifier board and sequencer from Elktronics provided color and great graphics to go with the black-and-white GBC camera. A stabilizing fin on the package kept the spin to a minimum. Without the fin the view from above would have constantly rotated.

On the morning of May 11th winds were about 10 MPH. The launch did not go smoothly and the package slammed into a building at the Wharton Municipal airport just southwest of Houston. The ten-meter Fireball beacon on 28.322 MHz by K7IRK was ripped off along with most of the ATV antenna. The computer reset to a dormant mode and the stabilization fin fell to the ground while the balloon and what was left of BLT-2 went into the sky.

Spirits were not high and neither was the balloon. At 27,000 feet the balloon burst prematurely possibly due to stresses encountered during the "hard" launch and the direction-finding team went into action. Within 45 minutes the package had been found 12 miles away in a field near Egypt, Texas and powered down. It was only noon. A quick vote was taken and we headed back to the airport to try again.

The ATV antenna was repaired, the stabilization fin was reattached, the computer was reset properly and the digital voice was reprogrammed. An hour later the back-up balloon was ready to go and so was BLT-3. This time the launch team was more organized. The winds were just over 10 MPH, but like a carefully choreographed dance team the crew went through the release sequence allowing the balloon, parachute, main package and 10-meter fireball to be freed in the proper order.

The fun began. Pictures from the onboard ATV system delighted everyone. Telemetry packets were received and displayed using laptop computers (Note Table 1) while CW enthusiasts wrote down telemetry data or just copied it in their heads. The 1.5 Watt TV signal was received in Dallas and Tyler to the north and the two-meter telemetry was heard on HT's out to 250 miles. The 50-mW ten-meter beacon could be heard in Tulsa, Oklahoma.

The BLT shortly after launch of BLT-3. A Cushcraft 416TB provides video downlink reception at the launch site. (Photo N5LCO)

This time the balloon traveled about 18 ground miles to a hay field near Wallis, Texas during its flight to over 90,000 feet. The recovery team found BLT-3 still operating with plenty of power for demonstrations at the Arlington, Texas Hamvention in early June.

The BLT project of South Texas was a

THE B.L.T.

HIGH COORDINATOR: WB5HLZ
PAYLOAD MASTER: WA5ZIB
PAYLOAD INTEGRATOR: WA5TWT
CAPTAIN VIDEO: N5JXO
COMPUTER WIZARD: WB5TTS
EARTH SOFTWARE: N5LCO

Analog Telemetry: WA5ZIB
Antennas: N5EM
ATV System: N5JXO
Back-up power: N5SUA
Balloon System: WB5HLZ
Camera System: WA5LHM
DF Leader: KC5CP
Digital Voice: N5JXO
Flight Computer: WB5TTS
Flight Plan: WB8ELK & WB5HLZ
Flight Software: WB5TTS
Mirror System: N5RPQ
Net Control: WB5HJV
Power System: WB5HLZ
Telemetry Software: N5LCO
Thermal Control: WA5TWT
Tracking Software: WB8ELK
VHF Transmitter: WA5ZIB
Video ID: WB8ELK
Video Sequencer: WB8ELK
Weatherman: KA3BKU

success. Plans continue for more exotic experiments this year and next. More ATV will be sent to the edge of space and improvements are expected in antenna design, packet operation, HF beacons and launch procedures.

Note: Portions of this article along with additional photos were printed in the July 1991 issue (Volume 4, Number 3) of *ATVQ*. ■

BALLOON LAUNCH TEAM CREW

WD5BDX	N5RPQ
WB5BGQ	N5SUA
KA3BKU	WB5TTS
KC5CP	WA5TWT
WD5DZC	WB5UUK
WB8ELK	WA5WOD
N5EM	WA5ZIB
WB5HJV	A. Alexy
WB5HLZ	J. Edinburgh
N5JXO	J. Johnson
WD5JRD	J. McKelvy
N5LCO	J. Mock
WA5LHM	S. Ross
N5LKJ	C. Summerville
N5MPN	Civil Air Patrol
WA5PCD	Brazos Valley ARC
N5QMG	Electronic Parts Outlet

This sample of BLT-3 telemetry data was recorded by Bob, N5LCO, and Ben, N5SUA, on 11-May-91 at the Wharton Municipal Airport, Texas.

Time (UTC)	Alt (ft)	Pressure (in.Hg.)	Inside Temp (F)	Outside Temp (F)	Velocity (ft/sec)
19:15:10	0	29.98000	158.000	84.000	0
19:15:48	259.3	29.64200	150.000	80.000	-8.3
19:16:28	538.1	29.34400	147.000	78.000	-7.0
19:17:05	933.1	28.92600	144.000	76.000	-10.7
19:17:43	1174.5	28.67300	142.000	75.000	-6.4
19:24:05	5078.4	24.82300	122.000	65.000	-12.7
19:31:04	10367.8	20.28500	109.000	45.000	-16.8
19:43:21	20474.4	13.47900	97.000	8.000	-13.7
19:54:32	30040.7	8.86900	86.000	-28.000	-14.0
20:06:58	40429.1	5.42500	73.000	-56.000	-13.7
20:18:00	50028.4	3.42000	66.000	-58.000	-14.8
20:29:02	60444.7	2.07300	73.000	-43.000	-21.7
20:38:15	70087.5	1.30500	62.000	-21.000	-19.0
20:47:33	80274.2	0.80500	82.000	-6.000	-17.3
20:55:23	91337.3	0.48000	68.000	5.000	-0.0
21:00:01	80038.1	0.81400	68.000	-57.000	69.7
21:01:59	71396.1	1.22600	67.000	-78.000	74.9
21:04:38	60454.8	2.07200	65.000	-77.000	62.7
21:07:13	50708.6	3.31000	72.000	-70.000	61.2
21:10:29	40579.2	5.38600	56.000	-34.000	46.3
21:14:23	30682.0	8.61300	49.000	2.000	38.5
21:18:52	20988.7	13.19000	46.000	34.000	33.2
21:25:13	10237.6	20.38800	50.000	58.000	23.3
21:26:27	9019.6	21.37200	54.000	64.000	9.7

Table 1. BLT-3 telemetry data as received via the two-meter packet transmissions from the package.

Final recovery of BLT-3 in a field near Wallis, Texas. (Photo WA5ZIB)

AMSAT News

AMSAT-NA Appoints New Officers

Over the summer months, a number of officers have resigned their positions for a variety of reasons. In response to these resignations AMSAT President, Doug Loughmiller, KO5I, has made the following appointments to fill these key positions.

Bruce Rahn, WB9ANQ, has agreed to serve as interim Vice President of Operations until a permanent replacement can be selected at the AMSAT Annual meeting in November. Bruce has played a key role in the commanding of the Microsat satellites and was recommended to fill the position by the former AMSAT Vice President of Operations, Courtney Duncan, N5BF, who had worked closely with Bruce on various operational issues. Bruce will continue to serve as lead Microsat command station in addition to assuming his interim duties.

Filling the slot of Executive Vice President which was left open by the resignation of Dr. John Champa, K8OCL, is Bill Tynan, W3XO,. Bill is a founding member of the organization and has most recently served as the Vice President Of Manned Space Operations for AMSAT. He will continue to oversee the Manned Space activities until a replacement can be identified and brought up to speed in this area. John, has indicated a desire to change his focus of activities upon the more technical aspects of satellite construction and indicates that he will continue to serve as a active volunteer and board member.

Finally, former Vice President of Field Operations Mike Crisler, N4IFD, returns to this position replacing Dr. Jeff Wallach, N5ITU. Jeff has been particularly busy with his professional work load leaving little time for volunteer day to day activities of the Field Organization. While Jeff is stepping down as the VP of Field Operations he has indicated that he wishes to continue to participate in various AMSAT activities. N4IFD has recently returned to the Field organization by contributing to a wide variety of activities including Hamfest and convention support, most notably this year's Dayton Hamvention.

AMSAT wishes to take this opportunity to thank Courtney, John and Jeff for all of their contributions to the AMSAT organization over the years. Their participation has been greatly appreciated.

AO-13 Operations Update

This past summer, AO-13 went through a number of spacecraft attitude reorientations. The change in August to Blat/Blon 180/20 was completed on Aug 15 and the transponder schedule changed to continuous Mode B.

At this attitude, the sun angle (angle of the sun to the solar panels) was 31 degrees, resulting in an effective illumination of 100*Cos(31) = 86% of maximum. However with the satellite antennas pointing 20 degrees out of the orbit plane, the "squint" or "pointing" angles were very, very poor.

To improve this situation, the attitude latitude was steadily reduced, 2 degrees at a time, and was changed to Blon/Blat 180/1, with an associated Sun angle of 39 degrees, or 78% illumination. The illumination improved about 4% a week, so that on Sept 18 when the Sun angle falls below 30 degrees, Modes JL and S were restored as previously announced.

As the attitude latitude was lowered the Sun angle was implicitly worsened, ultimately reaching 43 degrees, or 73% illumination. This is the poorest value at which we have ever operated AO-13. However, tests via the Whole Orbit Data collection facility showed that the battery remained adequately charged (just) during the heaviest usage at a weekend. The implication of this important trial is that during future attitude changes over the next two years our out-of-plane BLAT values can be restricted to about +10 degrees instead of the +25 degrees which had been feared. This then will ensure continuous good service on Mode B at these times.

There has been much animated discussion recently on AO-13 about the utility of Mode L. The feeling is essentially that "too much time is devoted to a transponder used too little by too few". To that end, James, G3RUH, Peter, DB2OS, and Graham, VK5AGR, the active AO-13 command stations would welcome constructive discussion about this. Suggestions as to alternative ways of structuring the schedule would be welcomed.

Remember in your "wild" deliberations the following constraints: Modes L and S are only useful when the squint angle is less than 20 degrees. Mode S transponder is only ON when Mode B is selected, and works FAR better if Mode B's passband is OFF (no transponder). Mode S beacon only when L is ON and J is OFF. Mode J can only be ON when Mode L is ON.

The command stations would like the feedback by Christmas 1991. They will then assess the suggestions, and see how best to reconfigure the flight software to accommodate them where possible. If there is no feedback, then of course there can't be any changes made! Send your comments to: James, G3RUH@GB7DDX, Peter, DB2OS@ DKØMAV, Graham, VK5AGR @ VK5WI thru terrestrial packet, UO-14/FO-20 or thru AMSAT Headquarters. ■

AMSAT Field Day 1991 at K4LMP

By Alan Sieg, WB5RMG
625 Larkspur Dr.
Kingsport, Tennessee. 37660

Field Day '91 could have started a little earlier for me this year. I had to work late Friday night, and didn't have a chance to finish those last minute "oughtas" until Saturday morning. I had been invited to join in the ritual of field day with the Scott County (Va.) Amateur Radio Club.

This new club has a high percentage of recently licensed hams, and this was to be their first ever field day adventure. They planned to operate from a remote hilltop in south-west Virginia, the site of their 6 and 2 meter repeaters.

Having returned to my native East Tennessee environment only about eight months ago, I was excited for several reasons to find a club that was interested in having the satellite experience. First, they were interested; second, they had no idea what could be done with a satellite; and third, I wanted more people in the immediate area that could discuss satellite things with me. After living in the metro Denver area for six years, I really miss all the AMSAT activity I had become accustomed to.

Saturday morning I still hadn't broken down the home station, but I knew it would be easy. My Yaesu FT-736 has only a few wires, and the preamps are inside, not up on the tower. Currently, only half of my antennas are on the tower, leaving the other KLM14C and KLM18C waiting in the garage. "This shouldn't take long", I thought, "pack some food and drinks into a cooler, some dry socks...a few things like that."

Fortunately, a few weeks earlier, I had found Mike, N4OFA, a budding satellite enthusiast, and enlisted his help in the preparation. Mike arrived at my house at about 10 a.m. with his big tent, an ice chest, and enough room in his pickup truck for the antennas. We had learned that the club planned to operate from the commercial power available at the repeater site, so we had rigged a U110 rotor onto my old TR44 for an AZ/EL combination. The rotor control boxes had been pre-wired and tested, so we just stuffed them into a trash bag. (It was sure to rain before we were ready.)

I had prepared a notebook with all of the schedules and antenna tracking information printed out for each pass, as well as some sheets explaining the different transponder configurations. Some photos I had taken in the Boulder Microsat lab would illustrate how small these birds could be. I had included a computer printed picture of the sun, as seen by the camera experiment in WEBERSAT. I wanted to show these guys everything I could about my satellite fever. Even if we contacted only a few other stations, it would be worth the effort. Then they would see that satellite communications was within their reach. This was my dream!

Noticing that it was almost 1300, I grabbed my UTC clock off the wall and said, "LETS GO!" As we approached the hill, we were talked in by KC4JMH, another Mike, leader of the Scott County group. We followed his directions; past the farm house, alongside the corn field, and through the gate next to the barn. Then up we went through the mud, around tree stumps, plowing through deep puddles, and spinning wheels in the wet grass to the very top of the hill. The tower and small building was once the home of some FM broadcast transmitter, but was now committed to amateur radio use. The clubs two repeaters share the tower with a 160m HF antenna.

They already had the two HF stations set up and were glad to see us. I think they actually thought we might provide them with some relief by helping with the late night shift on 75 meters. Picking a level spot just uphill from the building, we figured we should get the preamps configured and sealed into the plastic boxes before it started raining. Well, it was a mistake to announce such a plan out-loud. For as soon as I got the soldering gun plugged in, guess what, it started to rain. Stuffing all the preamp stuff back into the trash bag, we shifted our focus to the tent. That would give us a dry place to work on the preamps. It took a good 30 minutes to get the tent set up. We rigged a plastic tarp over the tent and the space immediately in front of, but wait... Whaddayoumean it ain't raining anymore!! Sure enough, as soon as we were ready for it, this summer shower was moving on to some dryer pasture to the northeast.

Good news! All the preamps, radios, and important stuff like that stayed dry, and the tent was all set up. The bad news was that we were soaked, and the storm had fully revitalized the numerous cow pies in our immediate vicinity. But we knew how wonderful it was that field day was upon us, and that it would be a great night out under the stars and satellites.

It took very little time to mount the preamps, the antennas, and apply liberal amounts of duct tape. We had a wooden closet pole inside a piece of pvc pipe for a cross boom, and a section from an old push-up mast. It was stuck at about the 13 foot level, but that was plenty enough. Mike, N4OFA, had procured for us four pieces of angle iron for stakes, and a bunch of plastic-

AO-13 cw operations from the tent. Left is Mike, N4OFA, and another Mike, KC4JMH, is to the left. (Photo WB5RMG)

jacketed clothesline guy wire.

The rig set-up was also a snap. Just plug everything in. We could have run all but the rotors from a 12 volt battery. Maybe next year we will even have 12 volt rotors. Mike wired power connections for the preamp remote control behind the radio, while I started scanning the downlink from AO-13. For some reason, I was only getting about 18 watts out of the rig, as compared to the 25 watts I usually have at home. The SWR looked ok, but I was not hearing myself too well on the downlink.

Mike comes to the rescue. His CW ability would make the difference (we won't discuss my CW just now). We had to get at least this first contact to get the bonus points for the club, anything after that would be icing on the cake. I gave Mike a quick review of how to lock the uplink VFO frequency to the downlink, reviewed the passband frequency limits, and left it with him.

When I returned a few minutes later, Mike said that he could almost work any station he heard, but that in the middle of a QSO the receiver would go dead. Well not all the way, but enough to where he had trouble copying. I listened for a minute and heard it drop out, and immediately suspected the preamp power. By wiggling the plug, sometimes it would drop out or come back on. Well, the next 30 minutes or so was spent trying to track down that problem. I was shaking coax, rotor cables, even the mast waiting for Mike to holler from the tent "That did it", or "It just came back on". The next step was to take down the antennas to inspect the preamps, and I was standing by the mast with a couple of the HF operators ready to help.

Well, one of the guys standing there with me just happened to have his 2 meter HT on, and noticed that when the repeater came on with the ID, Mike would say "That did it", and of course when the repeater's tail dropped out, Mike would dutifully report, "Whatever you just did, it came back on." I obtained a really dumb look for my face, and said something like "I guess that the repeater you're listening to is the one in this building, duh!"

Somehow, it had never entered my mind that the 50-some watt output of that repeater would be likely to de-sense my poor little 2 meter preamp. In spite of all this confusion, Mike had already worked 3 or 4 stations, and was well on his way to making history for the Scott County Amateur Radio Club.

By this time, I had expected the Mode B session to be over, but things were still going strong. We managed a few SSB contacts and then Mode B went off. Switching over to Mode J, we locked the VFOs and made a few more. All I could figure was that I had mis-read the latest schedule information and that the new schedule was effective June 17th, not July 17th. This would also mean that the squint angle was different, explaining why my signal was so weak when we started. When Mode J went off, we set out to run a long-wire over to the tower to use for a 10 meter antenna.


K4LMP Field Day Site, 1991, Scott County, Virginia. (Photo WB5RMG)

Just before dark, I reminded Mike that we hadn't eaten lunch, so we stopped long enough for a well-deserved hamburger, and some delicious hot-dogs cooked up on a portable gas grill. Such luxury, such class, what a feeling of accomplishment, what a Field Day experience.

(Continued on page 28)

Update on DSES 60' Dish Project

Deep Space Exploration Society 60' dish antennas on Table Mesa north of Boulder, Colorado. (WDØE photo).

By Jim White, WDØE

At last year's AMSAT-NA Symposium in Houston, attendees were advised of a project AMSAT-NA was participating in to rehabilitate two 60 foot dish antennas at the Boulder, Colorado radio quiet zone on Table Mesa. These dishes have now been leased to the Deep Space Exploration Society (DSES) by the National Institute of Standards and Technology (NIST), and work has begun to make them operational.

These antennas are functional to 10 GHz and have been found to be in reasonably good condition in spite of sitting unused for about 15 years. Present efforts are concentrated on servicing the drive mechanisms, repairing the problems found and cleaning up the adjacent equipment building. In and on the antennas themselves there are numerous pieces of old waveguide and cable that are left over from previous experiments which must be removed or secured. Old and unusable equipment has been removed, one dish has been successfully rotated in azimuth, and elevation movement will be attempted at the next work party. Several Denver/Boulder area AMSAT-NA members are participating in this all volunteer DSES project.

In addition to cleanup and repair, much additional work will be necessary to make the facility functional. Microprocessor controlled pointing is being considered; a new feed system and illumination antenna must be constructed, installed and calibrated; receivers and data recording equipment must be found and installed; preamps must be found and installed; to name just a few items. Very little of the original equipment in the building is usable.

A parallel effort is underway to solicit and select proposals for experiments that would use the facility. "Amateur" radio astronomy, reception of geosynchronous satellites, reception of EME signals and many other proposals are in the works. First functional use is probably several months away, but excitement is building, with 20 to 30 volunteers showing up for each work party.

As this is a purely volunteer effort, money is in very short supply. All funding so far has come from the pockets of the volunteers. Sources are being explored but are expected to be both few and a long time in coming. If you would like to contribute to this unique effort donations can be sent to Jim White, WDØE, at 6642 S. Dover Way, Littleton, Colorado 80123. I'll try to keep AMSAT members advised of progress through photos and short articles in the *Journal* as commissioning approaches. ■

Shown below from left to right: Tim White, NØISE, DSES volunteer, David Liberman, XE1TU, and Eugenio Rascon of the University of Mexico, Tak Okamoto, JA2PKI/N6MBM, JAMSAT President, and Jan King, W3GEY, AMSAT-NA VP Engineering, discuss rehabilitation plans and possible projects below one of the 60' dishes at the DSES facility (WDØE photo).

AMSAT Tech Tips

A "Natural" Way To Align Your Satellite Antennas

AMSAT Tech Tips are ideas which may not be "big enough" to be a full fledged article, but ideas that should be shared with the membership. If you have solved a problem in your shack in an interesting or unique way, why not share it with the rest of AMSAT. Submissions should be made to the Editorial Office (found on page 3).

A good way to double check the pointing accuracy of your antennas is to visually align them to a known point. With InstantTrack written by Franklin Antonio and distributed by AMSAT, you can do just that. InstantTrack not only keeps track of all of our favorite amateur satellites, it also continuously tracks the Sun and the Moon.

Point your antennas to the displayed azimuth and elevation of either the Sun or the Moon and then walk outside and see how close you are. Don't look directly into the Sun. If you're closer than five degrees in azimuth and elevation, congratulations. If you are farther off, you may want to consider some realignment.

After performing this operation, OSCAR 13 signals peak-up exactly on the azimuth and elevation as reported by InstantTrack. One evening, InstantTrack's star map screen reported that AO-13 was exactly in the cup of the Big-Dipper constellation. After slewing my antennas to the reported azimuth and elevation, I went outside and observed that my antennas were pointed exactly to the cup of the Dipper. — *de WB5ZDP*

(IT's tracking accuracy for the sun is something like 0.01 degree between years 1950 and 2050 (should be close enough for practically any antenna you want to align). Franklin Antonio reports the moon model was supposed to be accurate to 0.05 degrees over a longer period of time, but a typo in IT version 1.0 reduced the moon accuracy to something like 0.2 degrees. This error will be fixed in a later version of IT — Editor)

A Beginners Guide to OSCAR 13, by Keith Berglund, WB5ZDP, is a step-by-step guide to getting started on OSCAR 13. $7 in the U.S., $8 in Canada and Mexico, $10 elsewhere. Call AMSAT Hq., 301-589-6062 to order.

The American Geophysical Union Spring Meeting elected Dr. Tom Clark, W3IWI, as a Fellow. Shown from the left are W3IWI, N4HY, and W1HIS.

AMSAT Field Day 1991 at K4LMP

(Continued from page 25)

When the time came for RS10/11-RS12/13, I couldn't seem to get in on 2 meters, so we took over the two HF rigs for a few minutes to demonstrate Mode K. These HF operators were amazed that satellites could do that! Even more so when they realized that they could work Mode K without fancy antennas and preamps.

Well, all that was left for the night passes was AO-21, the newest bird. This is where I really felt the effect of having not practiced with this transponder yet. Mode B is very different using a Low Earth Orbit platform. The Doppler shift with Mode B is almost trivial with AO-13. However, with a LEO pass, the 435 MHz uplink starts about 10 kHz low, and ends the pass about 10 kHz high. By writing down both uplink and downlink frequencies during the pass I was able to make a rough graph of what this combined effect of two different Doppler rates would require that I do to stay on the same frequency for the duration of a pass; which was usually over by the time I had this figured out.

Also by this point, I could tell that our antenna point was lagging behind the required position. A quick check with WWV on the HF rig revealed that somewhere, somehow, the faithful battery powered UTC clock had been set back about 4 minutes. This had not been a problem with AO-13, but it makes a world of difference with a LEO.

By the time I had made all these discoveries, it was approaching 3 a.m., and I was ready to sleep until the next available pass. When the radio was quiet, we noticed something stirring around out there near the antennas. It was the N4"COW"s and KC4"BULL"s, the bovine residents of our hilltop retreat, wandering through to check out the excitement. We dutifully informed them that we had the situation under control, and that they should come back tomorrow, when it was light, and that we would explain everything.

Falling asleep on my air-mattress was great. Slight echos of Doppler shifted partial QSOs, visions of computer-less antenna tracking, the faint lingering taste of hamburger and homemade beer. I slept like a baby until the slow leak in my mattress resulted in uncomfortable contact with the hard ground under the tent. Dawn was just breaking, so I got up and made some field day coffee.

This time when AO-21 came around, we were ready. Mike was at the key, I had the rotor and VFO duty. It was a little tricky, but we managed 2 or 3 contacts. We even had a few sleepy HF onlookers, amazed that we knew where to point the antennas, and that it went by so fast.

The next pass came around just after a nice breakfast of bagels with cream-cheese and jam. It really is nice to have these breaks between passes. We were fully re-charged and ready to go. More stations were on AO-21 this pass, and I put on the headset and had Mike run the rotors. We worked no less than six stations on this 9 minute pass. And I must say, we had a certain glow of accomplishment. We even had the pleasure of saying good morning to Courtney, N5BF, during that last pass.

After all this excitement, it was with solemn, deliberately slow movements that we broke down the station. We knew that it may be some time before we would have this much fun again.

All told, we met all of our objectives. First, we made a total of 29 QSOs, 20 on the satellites, 9 local VHF/UHF (adding a total of 140 points to the score for K4LMP/3A-VA). Second, we exposed several new and even experienced hams to the wonders of satellite communications. And third, I have had several requests for schedule and transponder information. In other words, now there are more people talking about satellites. As an added bonus, rumors of this event have spread, and I have accepted an invitation to be a guest speaker at an upcoming meeting of the Johnson City Amateur Radio Association. This seems to be one of the more active clubs in the upper east Tennessee area, and they are expecting a sizeable turnout for their September meeting.

Now why didn't I have my video camera out there for field day? Maybe even include ATV next year....

I would like to thank Mike Van Winkle, KC4JMH, and the Scott County Amateur Radio Club for the invitation to join them, and for their interest and questions during Field Day 1991. I also want to thank Mike Wechsler, N4OFA, for his encouragement and valuable assistance during the planning and realization of this Field Day exercise.

(The results of the AMSAT-sponsored Field Day contest will be published in the November issue of the *Journal*. — *Editor*) ■

The 1991 AMSAT Symposium planning committee. Left to right are Skip Reymann, W6PAJ; Bunnie Davies; Gene Davies, AA6NP; John Fail, KL7GRF; Steve Smith, N8DEZ; Brian Tandrow, KR6B; and Dennis Killeby, K6IVY. (Photo by John Gibson, AA6NL)

Satellite Orbital Elements

September, 1991

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AO-10
1 14129U 83 58  B 91249.79423996 -.00000080  00000-0  99998-4 0  6955
2 14129  25.7894 126.2397 6056328 273.8972  23.2335  2.05883742 33926
UO-11
1 14781U 84 21  B 91253.13321695  .00002134  00000-0  38581-3 0   658
2 14781  97.8935 294.8478 0011609 262.1509  97.8367 14.67345349401908
RS-10/11
1 18129U 87 54  A 91254.39229017  .00000175  00000-0  18085-3 0  8154
2 18129  82.9319 355.1497 0010465 311.1403  48.8848 13.72211598211416
AO-13
1 19216U 88 51  B 91240.98808188 -.00000098  00000-0  39474-3 0  2820
2 19216  56.8192  75.2704 7227247 263.2074  17.6403  2.09702987 24553
FO-20
1 20480U 90 13  C 91243.38600691  .00000022  00000-0  77790-4 0  2417
2 20480  99.0372 211.3032 0541320 131.0680 233.8504 12.83186350 73206
AO-21
1 21087U          91254.22368980  .00000161  00000-0  15852-3 0  1283
2 21087  82.9443 170.0757 0036857  20.9648 339.3001 13.74408212 30841
RS-12/13
1 21089U 91  7  A 91251.88090678  .00000147  00000-0  14525-3 0  1298
2 21089  82.9197  42.0518 0030912  46.9247 313.4489 13.73922521 29632
UO-14
1 20437U 90  5  B 91251.74368580  .00000372  00000-0  16235-3 0  4109
2 20437  98.6611 330.6929 0010812 285.3368  74.6585 14.29243609 84926
AO-16
1 20439U 90  5  D 91252.40394281  .00000577  00000-0  24243-3 0  3117
2 20439  98.6674 331.7434 0010352 284.5010  75.4998 14.29326640 85020
DO-17
1 20440U 90  5  E 91254.47884679  .00000597  00000-0  25001-3 0  3130
2 20440  98.6674 333.8677 0010352 278.4921  81.5050 14.29422672 85329
WO-18
1 20441U 90  5  F 91254.51662878  .00000531  00000-0  22347-3 0  3061
2 20441  98.6670 333.9571 0011014 277.6522  82.3408 14.29455272 85333
LO-19
1 20442U 90  5  G 91254.48638593  .00000543  00000-0  22789-3 0  3079
2 20442  98.6669 333.9978 0011257 277.4258  82.5643 14.29533518 85339
UO-22
1 21575U 91 50  B 91254.23448140  .00000814  00000-0  29328-3 0   162
2 21575  98.5414 327.5541 0008726  59.7143 300.4901 14.36164440  8066
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Phase III-D has a Go For Launch

(Continued from page 1)

Mounted within the spacecraft will be a conical launch adaptor to support spacecraft above the Phase 3D, currently shown to be two "Cluster" spacecraft. The AR502 launch will have a total of four Cluster spacecraft aboard. The launch adaptor in the Phase 3D will have to support 2.5 metric tons at a distance of 2m above the top. The penalty of this launch stack is that the Falcon would have to carry the mass of this adaptor, as well as the propellant needed to take this added mass to our final orbit. Normally, the conical adaptor is jettisoned after the release of the main payload, becoming another piece of space junk. AMSAT could be considered one of the first Space Ecologists, by taking the "space junk" and recycling it into a viable communications satellite.

Since ESA's announcement, excitement about this project has risen to a fever pitch. You can hear it in the voices of the design team. Although the design constraints of the spacecraft frame has created numerous engineering challenges, the Falcon design team have already sunk their teeth deep into these problems. If we were to use Phase III-C technology for the design of the propellant storage tanks, the tanks themselves would have a mass of nearly 80kg (remember we have a 500kg limit for the entire spacecraft). We are investigating new technology which would reduce that mass to only 14kg.

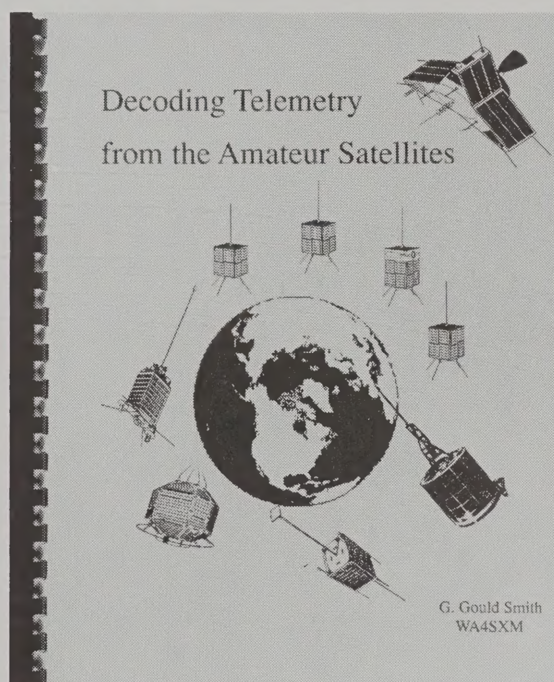
As resourceful as the Falcon design team might be, they cannot solve all the problems on their own. Although, specifics are not presently available for publications, a number of commercial concerns in the space industry are committing significant resources and materials to the Falcon project. As has been the case with most of the recent OSCARs, it has been through the generous donations of Corporate sponsors, that AMSAT has been able to stay on the leading edge of spacecraft development.

We are well on our way to accomplishing the next milestone in AMSAT history, Phase III-D "The Falcon". But we need your support to get the Falcon to fly. Renewing your membership in AMSAT does two things, it provides funds for spacecraft development and it will keep you abreast of the developments by reading them here in the *AMSAT Journal.* The minutes of the last design meeting were started in the July 1991 *AMSAT Journal* and are continued in this issue. In future issues of the *Journal*, we hope to provide more information about the Falcon design effort. ■

AMSAT Announces a new Publication:

Decoding Telemetry from the Amateur Satellites.

Every Amateur Satellite is speaking to you — but do you understand what it is saying? The “mystery” of satellite telemetry is solved!



All Amateur Radio Satellites have had a telemetry system on-board providing us here on the ground a window into the health and well being of the bird. G. Gould Smith, WA4SXM, has authored a compilation of information on each of the currently operating Amateur Satellites from UO-11 thru AO-21, including the RS series of satellites. He describes the telemetry systems of the earlier birds and proceeds up through the latest techniques.

The book sets aside an entire chapter to each satellite, describing in detail the telemetry format and conversion formulas along with station requirements and operating techniques. In addition, Gould describes how various software programs can be used to extract the data automatically. Screen shots of the various programs let you see directly what each program can do.

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